Please note that study methods and explanations of analyses for Hiawatha Lake can be found within the Town of Winchester Town-wide Management Plan document.

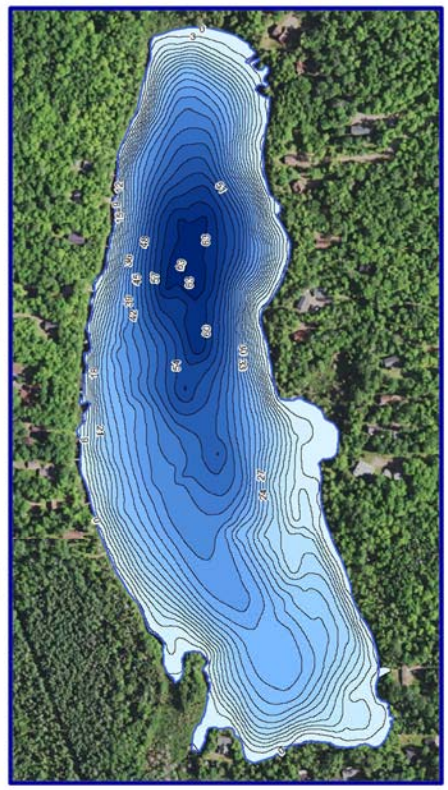
8.2 Hiawatha Lake

An Introduction to Hiawatha Lake

Hiawatha Lake, Vilas County, is a deep, headwater mesotrophic drainage lake with a maximum depth of 58 feet, a mean depth of 32 feet, and a surface area of approximately 38 acres (Hiawatha Lake – Map 1). Its surficial watershed encompasses approximately 819 acres comprised mainly of intact forests and wetlands. Water from Hiawatha Lake flows out to Little Papoose Lake and into the Manitowish River. In 2015, 26 native aquatic plant species were located within the lake, of which rolled water moss (*Fontinalis sphagnifolia*) was the most common.

Lake at a Glance - Hiawatha Lake

Morphology	
LakeType	Deep, Headwater Drainage
Surface Area (Acres)	38
Max Depth (feet)	58
Mean Depth (feet)	32
Perimeter (Miles)	1.4
Shoreline Complexity	2.6
Watershed Area (Acres)	819
Watershed to Lake Area Ratio	21:1
Water Quality	
Trophic State	Mesotrophic
Limiting Nutrient	Phosphorus
Avg Summer P (µg/L)	17.4
Avg Summer Chl-α (µg/L)	4.6
Avg Summer Secchi Depth (ft)	5.7
Summer pH	7.2
Alkalinity (mg/L as $CaCO_3$)	14.6
Vegetation	
Number of Native Species	26
NHI-Listed Species	0
Exotic Species	0
Average Conservatism	7.2
Floristic Quality	25.8
Simpson's Diversity (1-D)	0.87



Descriptions of these parameters can be found within the town-wide portion of themanagement plan

8.2.1 Hiawatha Lake Water Quality

It is often difficult to determine the status of a lake's water quality purely through observation. Anecdotal accounts of a lake "getting better" or "getting worse" can be difficult to judge because a) a lake's water quality may fluctuate from year to year based upon environmental conditions such as precipitation, and b) differences in observation and perception of water quality can differ greatly from person to person. It is best to analyze the water quality of a lake through scientific data as this gives a concrete indication as to the health of the lake, and whether its health has deteriorated or improved. Further, by looking at data for similar lakes regionally and statewide, the status of a lake's water quality can be made by comparison.

In 2015, a stakeholder survey was sent to 33 Hiawatha Lake riparian property owners. Approximately 42%, or 14 surveys were completed. Given the relatively low response rate, the results of the stakeholder survey cannot be interpreted as being statistically representative of the population sampled. At best, the results may indicate possible trends and opinions about the stakeholder perceptions of Hiawatha Lake, but cannot be stated with statistical confidence. The full survey and results can be found in Appendix B. When asked about Hiawatha Lake's current water quality, 100% of respondents described the current water quality of Hiawatha Lake as *excellent* or *good* (Figure 8.2.1-1). When asked how water quality has changed in Hiawatha Lake since they first visited the lake, approximately 72% of respondents indicated water quality has *remained the same*, 14% indicated it has *somewhat improved*, and 14% indicated it has *somewhat degraded* (Figure 8.2.1-1).

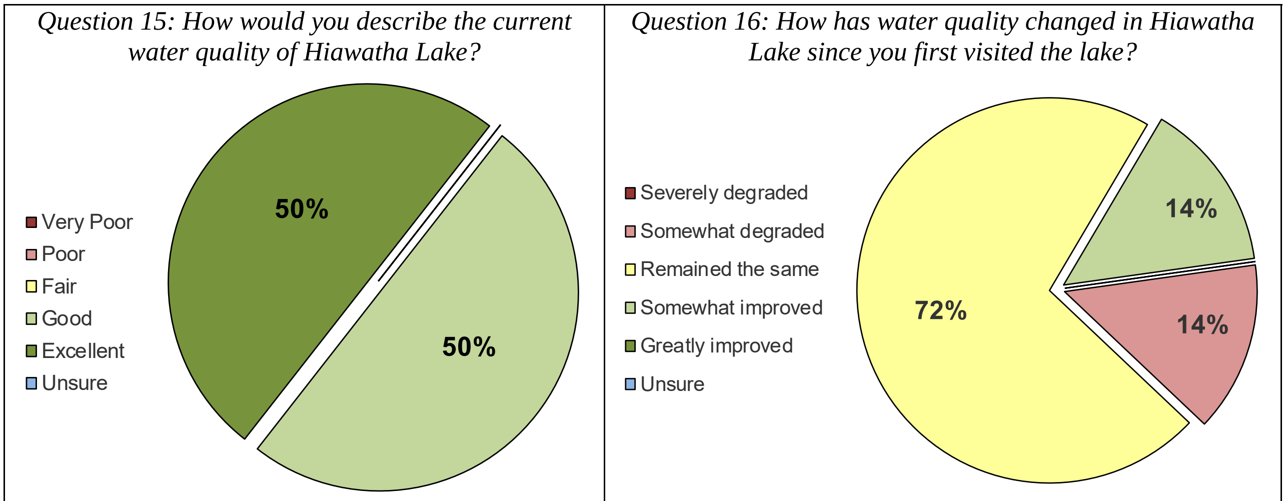


Figure 8.2.1-1. Hiawatha Lake stakeholder survey responses regarding the lake's current and historical water quality. Created using responses from 14 (42%) respondents of 33 surveys distributed.

Near-surface total phosphorus data for Hiawatha Lake are available from 1979 and annually from 2000-2015 (Figure 8.2.1-2). Historical annual average near-surface total phosphorus concentrations range from *excellent* to *good* for deep, headwater drainage lakes in Wisconsin, and concentrations measured in 2015 fell into the *excellent* category. The weighted average of summer near-surface total phosphorus concentrations using all data that are available falls into the *excellent* category with a value of 17.4 µg/L, and is comparable to the median concentration for other deep, headwater drainage lakes in Wisconsin (17.0 µg/L) and slightly lower than the median concentration for all lake types within the Northern Lakes and Forests (NLF) ecoregion (21.0 µg/L).

Near-surface total phosphorus concentrations in Hiawatha Lake were slightly higher than average in 2010, 2011, 2013, and 2014; however, trends analysis indicates that these slightly elevated phosphorus concentrations to not represent a statistically valid trend. Precipitation data obtained from nearby Hurley, WI indicate that precipitation was above average in 2010, 2013, and 2014, and the increased runoff to Hiawatha Lake is the likely reason for these higher-than-average phosphorus concentrations (Figure 8.2.1-3). Large precipitation events likely 'flush' the large, coniferous wetland which drains to Hiawatha Lake from the north increasing the amount of phosphorus and other nutrients delivered to the lake. While there was a measured increase in total phosphorus in these years, these increases were not significant and are considered *good* for deep, headwater drainage lakes. As is discussed further in Hiawatha Lake Watershed Section, measured near-surface total phosphorus concentrations align with predicted concentrations based on watershed modeling.

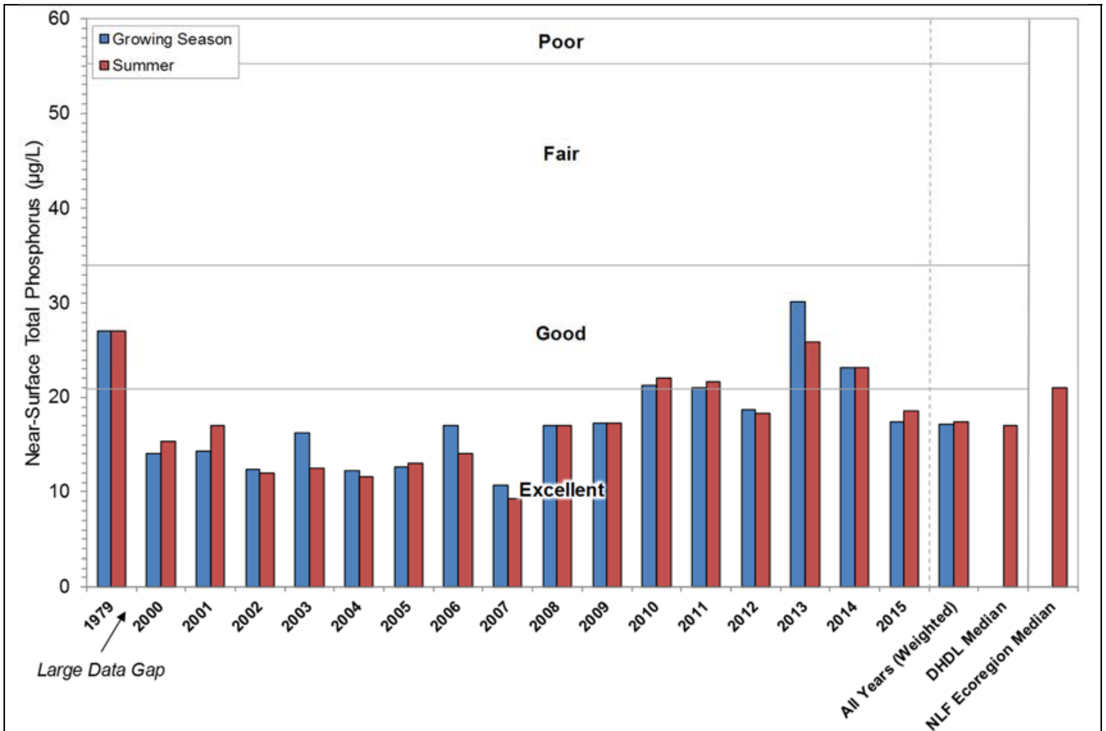


Figure 8.2.1-2. Hiawatha Lake average annual near-surface total phosphorus concentrations and median near-surface total phosphorus concentrations for state-wide deep, headwater drainage lakes (DHDL) and Northern Lakes and Forests (NLF) ecoregion lakes. Water Quality Index values adapted from WDNR PUB WT-913.

The mid-summer total nitrogen to total phosphorus ratio measured from Hiawatha Lake in 2015 was 48:1, indicating that phosphorus is the limiting nutrient, or the nutrient controlling phytoplankton growth in Hiawatha Lake. Chlorophyll-*a* concentrations, a measure of phytoplankton abundance, are available for Hiawatha Lake from 1979 and 2000-2015 (Figure 8.2.1-4). With the exception of 1979, 2012, and 2013, all historical data and the data collected in 2015 fall into the *excellent* category for deep, headwater drainage lakes. The average weighted summer chlorophyll-*a* concentration for Hiawatha Lake is 4.6 µg/L, which is comparable to the median chlorophyll-*a* concentration for other deep, headwater drainage lakes in Wisconsin (5.0 µg/L) and slightly lower than the median concentration for all lake types within the NLF ecoregion (5.6 µg/L). The low level of phytoplankton production in Hiawatha Lake is a result of the low concentrations of phosphorus, the nutrient regulating phytoplankton production.

The higher chlorophyll-*a* concentrations in 2012 and 2013 (and likely 1979) were likely the result of extremes in annual climatic variations. Lakes in northern Wisconsin had one of the earliest ice-off dates on record in 2012, and the summer of 2012 was one of the warmest on record in Wisconsin. While phosphorus concentrations were not higher than average in 2012, Hiawatha Lake's water temperature was likely higher which facilitates greater and more rapid phytoplankton production. In 2013, precipitation was approximately 20 inches above normal which likely delivered a higher amount of phosphorus to Hiawatha Lake from its watershed.

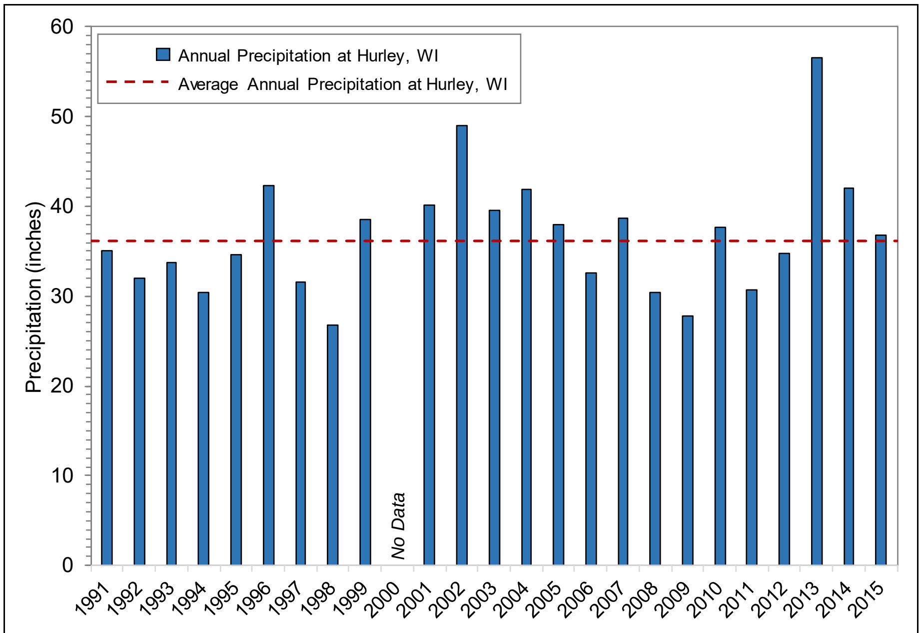


Figure 8.2.1-3. Total annual precipitation measured in Hurley, WI. Data obtained from National Oceanic and Atmospheric Administration website (https://www.ncdc.noaa.gov/cdo-web/).

With higher phosphorus concentrations in 2013, more phytoplankton were produced. While chlorophyll-*a* concentrations were elevated in these years, they still fell within the *good* category for deep, headwater drainage lakes, and these variations in both phosphorus and chlorophyll-*a* are natural and expected given climatic changes from year to year. Overall, trends analysis indicates that like chlorophyll-*a* concentrations have remained relatively stable over the time period for which data are available, and no trends (positive or negative) are occurring over time.

Secchi disk transparency data from Hiawatha Lake are available from 1979 and 1998-2015 (Figure 8.2.1-5). Average annual growing season and summer Secchi disk transparency data range from *excellent* to *fair* for deep, headwater drainage lakes in Wisconsin. The weighted average summer Secchi disk transparency in Hiawatha Lake is 5.7 feet, falling below the median value for other deep, headwater drainage lakes in Wisconsin (10.8 feet) and the median value for all lake types within the NLF ecoregion (8.9 feet). Secchi disk transparency is lower than expected in Hiawatha Lake given the relatively low chlorophyll-*a* concentrations, and is an indication that another factor other than phytoplankton abundance is influencing the lake's clarity.

Abiotic suspended particulates, such as sediment, can also cause a reduction in water clarity. However, *total suspended solids*, a measure of both biotic and abiotic suspended particles within the water, were below the limit of detection in Hiawatha Lake in 2015 indicating minimal amounts of suspended material within the water. While suspended particles are minimal in Hiawatha Lake, water clarity can also be influenced by dissolved compounds within the water. Many lakes in the northern region of Wisconsin contain higher concentrations of natural dissolved organic acids that originate from decomposing plant material within wetlands in the lake's watershed. In higher concentrations, these dissolved organic compounds give the water a tea-like color or staining and decrease water clarity.

A measure of water clarity once all of the suspended material (i.e. phytoplankton and sediments) have been removed, is termed *true color*, and indicates the level of dissolved material within the water. True color values measured from Hiawatha Lake in 2015 averaged 175 SU (standard units), indicating the lake's water is *highly tea-colored*. Based on Hiawatha Lake's chlorophyll-*a* concentrations, Secchi disk transparency is predicted to be approximately 9-10 feet; however, the high concentrations of dissolved organic acids in the lake reduce the water's clarity to the measured 5.7 feet.

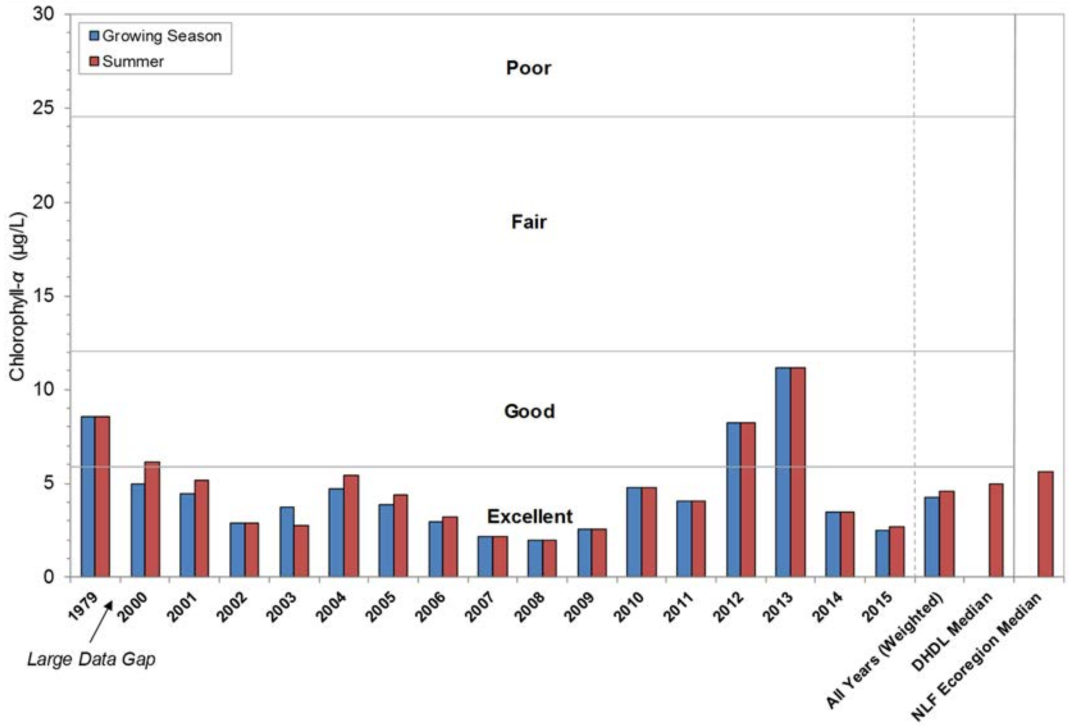


Figure 8.2.1-4. Hiawatha Lake average annual chlorophyll-α concentrations and median chlorophyll-α concentrations for state-wide deep, headwater drainage lakes (DHDL) and Northern Lakes and Forests (NLF) ecoregion lakes. Water Quality Index values adapted from WDNR PUB WT-913.

Water clarity in Hiawatha Lake has been below average since 2013, and is likely due to the increased precipitation in 2013 and 2014 which delivered higher amounts of dissolve organic acids from wetlands into the lake. While water clarity was considered *fair* in 2015, this is not an indication that Hiawatha Lake's water quality is degraded. It is important to understand that the staining of the lake's water is natural, and the level of staining is going to be highly dependent upon annual precipitation from year to year.

To determine if internal nutrient loading (discussed in town-wide section of management plan) occurs in Hiawatha Lake, near-bottom phosphorus concentrations are compared against those collected from the near-surface. Near-bottom total phosphorus concentrations were measured on three occasions from Hiawatha Lake in 2015 and once in 2016, and historical near-bottom total phosphorus concentrations are available from 1979. (Figure 8.2.1-6). As illustrated, on some occasions near-bottom total phosphorus concentrations were slightly higher than those measured at the surface. Typically, internal nutrient loading is considered to be a significant source of phosphorus to a lake if near-bottom concentrations exceed 200 µg/L, and concentrations measured in 2015 did not exceed 40 µg/L. This indicates that internal nutrient loading is not a significant source of phosphorus to Hiawatha Lake.

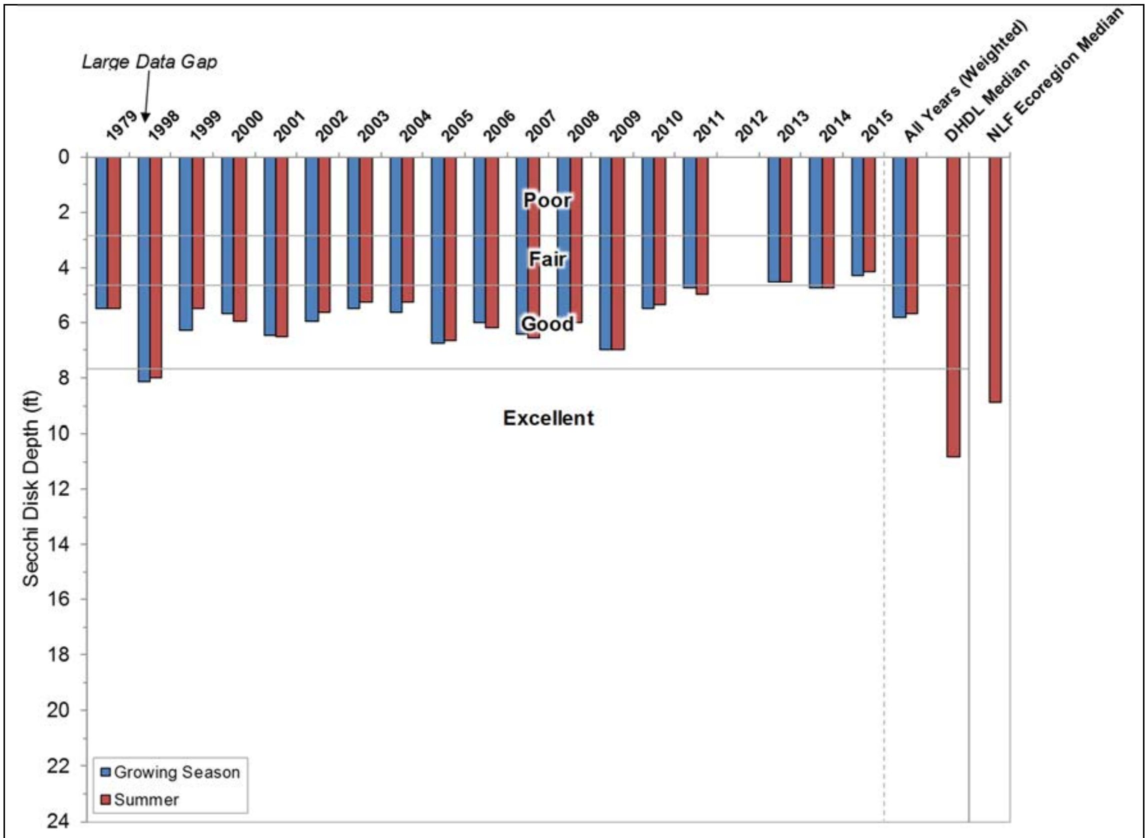


Figure 8.2.1-5. Hiawatha Lake average annual chlorophyll-α concentrations and median chlorophyll-α concentrations for state-wide deep, headwater drainage lakes (DHDL) and Northern Lakes and Forests (NLF) ecoregion lakes. Water Quality Index values adapted from WDNR PUB WT-913.

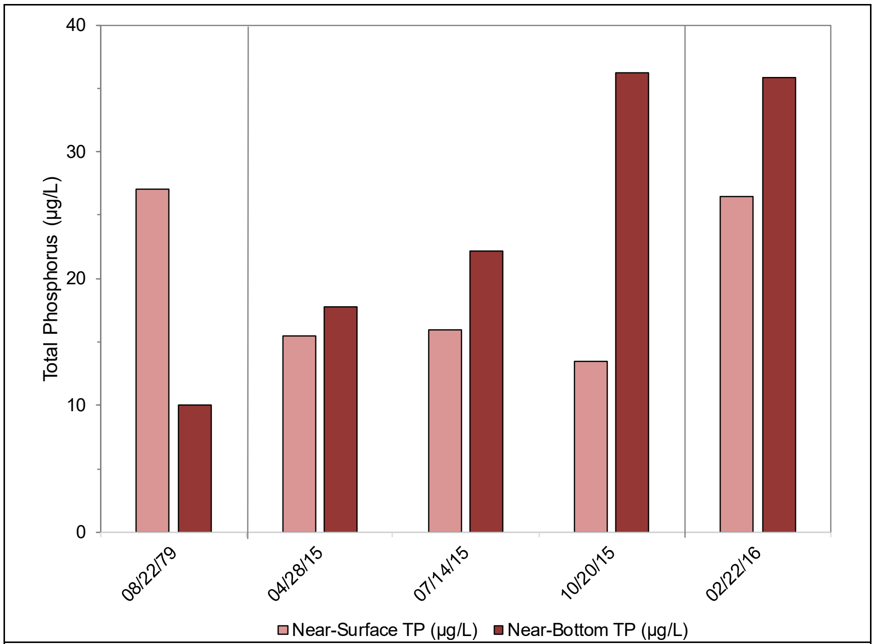


Figure 8.2.1-6. Hiawatha Lake available near-bottom total phosphorus concentrations and corresponding near-surface total phosphorus concentrations.

Hiawatha Lake Trophic State

Figure 8.2.1-7 contains the weighted average Trophic State Index (TSI) values for Hiawatha Lake. These TSI values are calculated using summer near-surface total phosphorus, chlorophyll-*a*, and Secchi disk transparency data collected as part of this project along with available historical data. In general, the best values to use in assessing a lake's trophic state are chlorophyll-*a* and total phosphorus, as water clarity can be influenced by other factors other than phytoplankton such as dissolved organic compounds. The closer the calculated TSI values for these three parameters are to one another indicates a higher degree of correlation.

The weighted TSI values for phosphorus and chlorophyll-*a* in Hiawatha Lake indicate the lake is currently in a mesotrophic state. The fact that the TSI values for total phosphorus and chlorophyll-*a* are nearly identical is an indication that chlorophyll-*a* production is regulated by total phosphorus. In contrast, the weighted TSI value for Secchi disk transparency is higher, falling into the eutrophic category. The higher TSI value for Secchi disk transparency when compared to the TSI value for chlorophyll-*a* indicates that water clarity is influenced by another factor other than phytoplankton abundance. As discussed previously, dissolved organic acids that stain Hiawatha Lake's water are the primary factor influencing water clarity in Hiawatha Lake. The trophic state of Hiawatha Lake is comparable to other deep, headwater drainage lakes in Wisconsin and slightly lower when compared to all lake types within the NLF ecoregion.

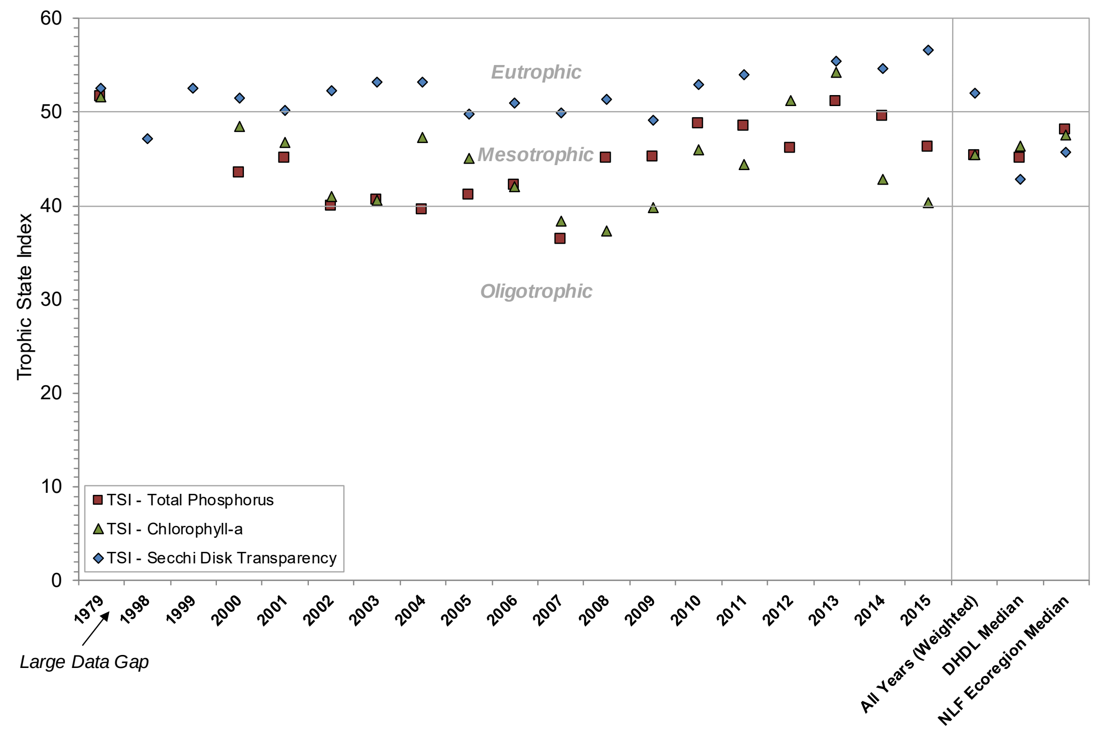


Figure 8.2.1-7. Hiawatha Lake, statewide deep, headwater drainage lakes (DHDL), and Northern Lakes and Forests (NLF) ecoregion lakes Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Hiawatha Lake

Dissolved oxygen and temperature profile data were collected during each water quality sampling event conducted by Onterra ecologists. These data are displayed in Figure 8.2.1-8. Hiawatha Lake is *dimictic*, meaning the lake remains stratified during the summer (and winter) and completely mixes, or turns over, once in spring and once in fall. During the summer, the surface of the lake warms and becomes less dense than the cold layer below, and the lake thermally stratifies. Given Hiawatha Lake's deeper nature, wind and water movement are not sufficient during the summer to mix these layers together, only the warmer, upper layer will mix. As a result, the bottom layer of water no longer receives atmospheric diffusion of oxygen, and decomposition of organic matter within this layer depletes available oxygen.

In fall as surface temperatures cool, the entire water column is again able to mix which re-oxygenates the hypolimnion. During the winter, the coldest temperatures are found just under the overlying ice, while oxygen gradually declines once again towards the bottom of the lake. In February of 2016, oxygen concentrations remained above 2.0 mg/L throughout the majority of the water column, indicating that fishkills as a result of winter anoxia are likely not a concern in Hiawatha Lake.

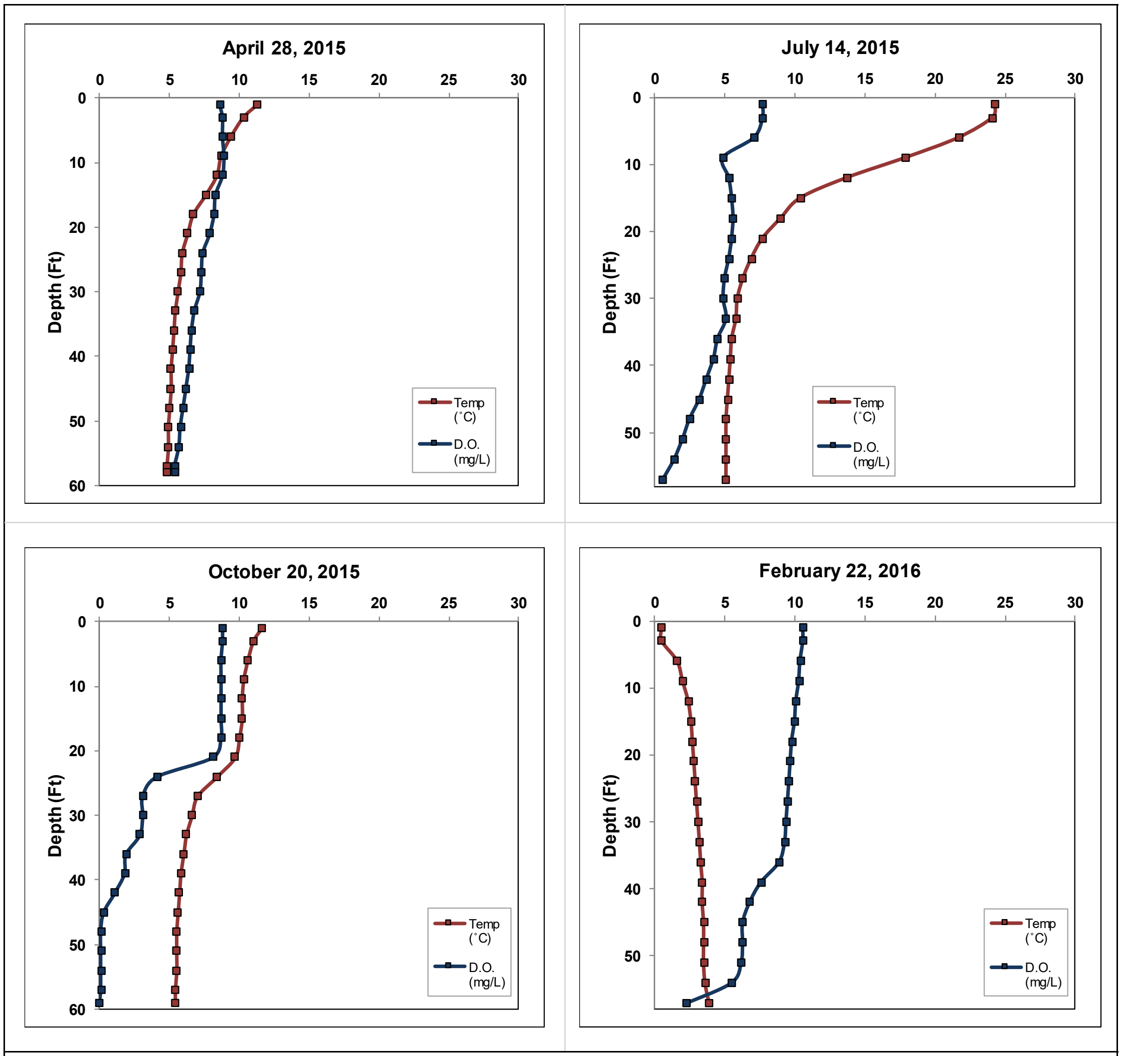


Figure 8.2.1-8. Hiawatha Lake 2015/16 dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected from Hiawatha Lake

The previous section is centered on lake eutrophication. However, parameters other than water clarity, nutrients, and chlorophyll-*a* were collected as part of the project. These other parameters were collected to increase the understanding of Hiawatha Lake's water quality and are recommended as a part of the WDNR long-term lake trends monitoring protocol. These parameters include pH, alkalinity, and calcium.

As the Town-wide Section explains, the pH scale ranges from 0 to 14 and indicates the concentration of hydrogen ions (H^+) within the lake's water and is thus an index of the lake's acidity. Hiawatha Lake's mid-summer surface water pH was measured at roughly 7.2 in 2015. This value indicates Hiawatha Lake's water is near neutral and falls within the normal range for Wisconsin lakes. Fluctuations in pH with respect to seasonality are common; in-lake processes such as photosynthesis by plants act to reduce acidity by carbon dioxide removal while decomposition of organic matter adds carbon dioxide to water, thereby increasing acidity. A lake's pH is primarily determined by the water's alkalinity, or a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. Hiawatha Lake's average alkalinity measured in 2015 was 14.6 mg/L as $CaCO_3$. This value falls within the expected range for northern Wisconsin lakes, and indicates that Hiawatha Lake has low sensitivity to fluctuations in pH from acid rain.

Water quality samples collected from Hiawatha Lake in 2015 were also analyzed for calcium. Calcium concentrations, along with pH, are currently being used to determine if a waterbody is suitable to support the invasive zebra mussel, as these animals require calcium for the construction of their shells. Zebra mussels typically require higher calcium concentrations than Wisconsin's native mussels, and lakes with calcium concentrations of less than 12 mg/L are considered to have very low susceptibility to zebra mussel establishment. The accepted suitable pH range for zebra mussels is 7.0 – 9.0, and Hiawatha Lake's pH falls within this range. Hiawatha Lake's calcium concentration in 2015 was 6.1 mg/L, indicating the lake has *very low susceptibility* to zebra mussel establishment. Plankton tows were completed by Onterra ecologists at three locations in Hiawatha Lake in 2015 that underwent analysis for the presence of zebra mussel veligers, their planktonic larval stage. Analysis of these samples were negative for zebra mussel veliger and for the invasive spiny water flea.

8.2.2 Hiawatha Lake Watershed Assessment

Hiawatha Lake's surficial watershed encompasses approximately 819 acres (Figure 8.2.2-1 and Hiawatha Lake – Map 2). The watershed is comprised mainly of natural land cover types including forests (78%), wetlands (17%), and the lake surface itself (5%) (Figure 8.2.2-1). Less than 1% is comprised of rural residential areas and pasture/grass. Wisconsin Lakes Modeling Suite (WiLMS) modeling indicates that Hiawatha Lake's residence time is approximately 1.3 years, or the water within the lake is completely replaced once every 1.3 years.

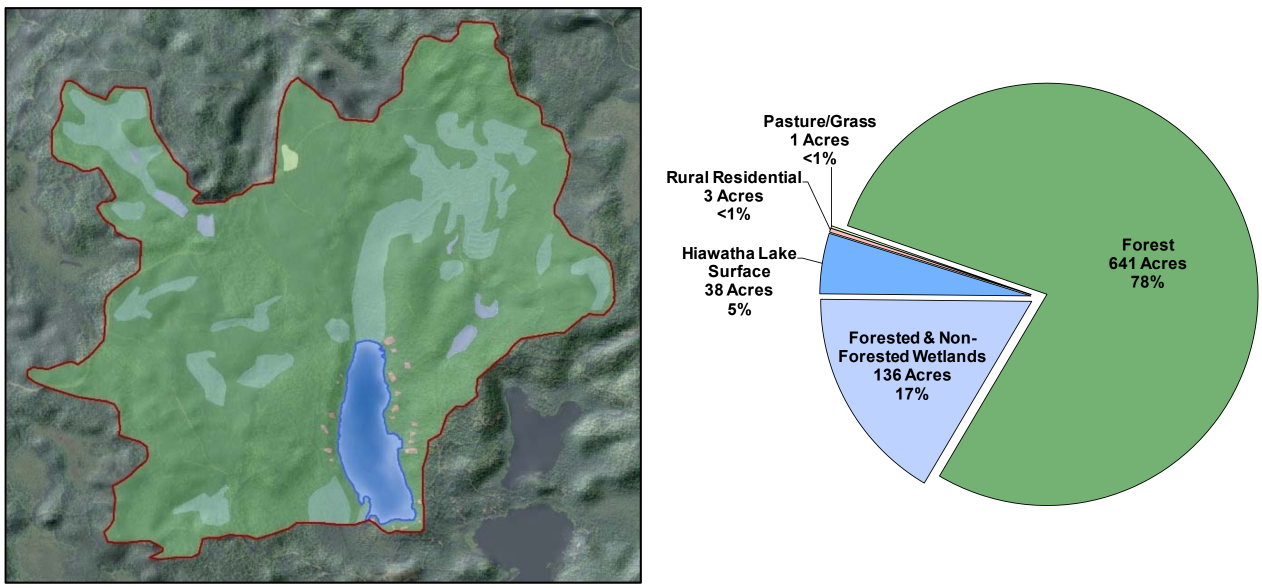


Figure 8.2.2-1. Hiawatha Lake watershed boundary (red line) and proportion of land cover types. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

Using the land cover types and their acreages within Hiawatha Lake's watershed, WiLMS was utilized to estimate the annual potential phosphorus load delivered to Hiawatha Lake from its watershed. In addition, data obtained from a stakeholder survey sent to Hiawatha Lake riparian property owners in 2015 was also used to estimate the amount of phosphorus loading to the lake from riparian septic systems. The model estimated that a total of approximately 76 pounds of phosphorus are delivered to Hiawatha Lake from its watershed on an annual basis (Figure 8.2.2-2).

Of the estimated 76 pounds of phosphorus being delivered to Hiawatha Lake on an annual basis, the majority (51 pounds - 67%) originates from forests, 13 pounds (17%) from wetlands, 11 pounds (15%) from atmospheric deposition directly onto the lake's surface, and 1 pounds (1%) from riparian septic systems. The phosphorus delivered from rural residential areas and pasture/grass were negligible. Using the estimated annual potential phosphorus load, WiLMS predicted an in-lake growing season average total phosphorus concentration of 16 µg/L, which is essentially identical to the measured growing season average total phosphorus concentration of 17.1 µg/L. The similarity between the predicted and measured total phosphorus concentrations in Hiawatha Lake is an indication that this is an accurate model of the lake's watershed and that there are no significant, unaccounted sources of phosphorus entering the lake.

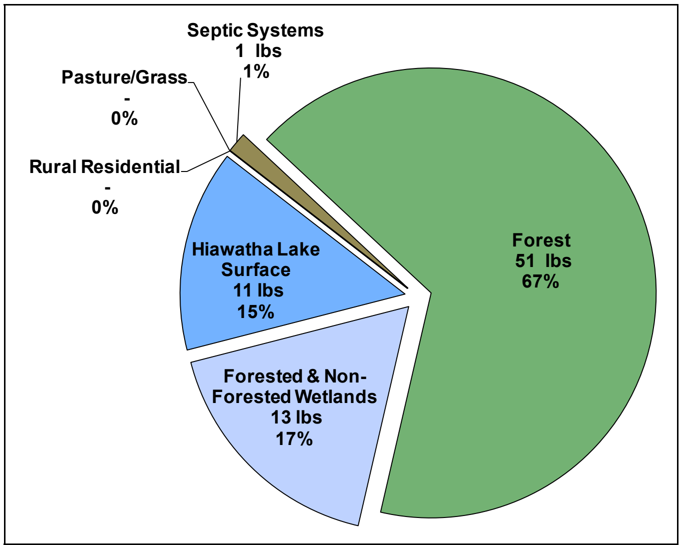


Figure 8.2.2-2. Hiawatha Lake estimated potential annual phosphorus loading. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Using the WiLMS model for Hiawatha Lake's watershed, scenarios can be run to determine how Hiawatha Lake's water quality would change given alterations to its watershed. For example, if 25% of the forests within Hiawatha Lake's watershed were converted to pasture/grass, phosphorus concentrations are predicted to increase from the current growing season concentration of 17.1 µg/L to 21 µg/L. This increase in total phosphorus would result in chlorophyll-*a* concentrations increasing from the current growing season average of 4.6 µg/L to 6.0 µg/L, and Secchi disk transparency is predicted to decline from the current growing season average of 5.7 feet to 4.7 feet. In another scenario, if 25% of the forests in Hiawatha Lake's watershed were converted to row crop agriculture, phosphorus concentrations are predicted to increase to 34 µg/L, chlorophyll-*a* concentrations would increase to 12 µg/L, and Secchi disk transparency would decline to 3.0 feet. This modeling illustrates the importance of the natural land cover types within Hiawatha Lake's watershed in maintaining the lake's excellent water quality.

8.2.3 Hiawatha Lake Shoreland Condition

Shoreland Development

As is discussed within the Town-wide Section, one of the most sensitive areas of a lake's watershed is the immediate shoreland zone. This transition zone between the aquatic and terrestrial environment is the last source of protection for the lake against pollutants originating from roads, driveways, and yards above, and is also a critical area for wildlife habitat and overall lake ecology. In the late-summer of 2015, the immediate shoreland of Hiawatha Lake was assessed in terms of its development, and the shoreland zone was characterized with one of five shoreland development categories ranging from urbanized to completely undeveloped.

The 2015 survey revealed that Hiawatha Lake has stretches of shoreland that fit four of the five shoreland assessment categories (Figure 8.2.3-1). In total, 1.0 miles (72%) of the 1.4-mile shoreland zone were categorized as natural/undeveloped or developed-natural, or shoreland types that provide the most benefit to the lake and should be left in their natural state if possible. Approximately 0.04 miles (3%) of the shoreland was categorized as developed-unnatural, shorelands which provide little benefit to and may actually adversely impact the lake. If restoration of Hiawatha Lake's shoreland is to occur, primary focus should be placed on these shoreland areas. Hiawatha Lake – Map 3 displays the locations of these shoreland categories around the entire lake. No areas of Hiawatha Lake's shoreland zone were found to be in an urbanized state.

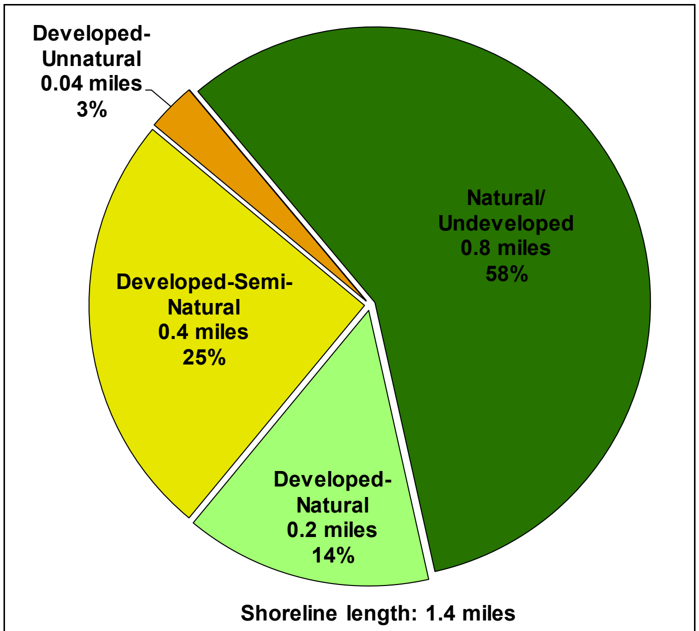


Figure 8.2.3-1. Hiawatha Lake shoreland categories and total lengths. Based upon a late-summer 2015 survey. Locations of these categorized shorelands can be found on Hiawatha Lake - Map 3.

Coarse Woody Habitat

A survey for coarse woody habitat was conducted in conjunction with the shoreland assessment (development) survey on Hiawatha Lake in 2015. Coarse woody habitat was identified, and classified in several size categories (2-8 inches diameter, >8 inches diameter and cluster) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. As discussed in the Town-wide Section, research indicates that fish species prefer some branching as opposed to no branching on coarse woody habitat, and increasing complexity is positively correlated with higher fish species richness, diversity and abundance (Newbrey et al. 2005).

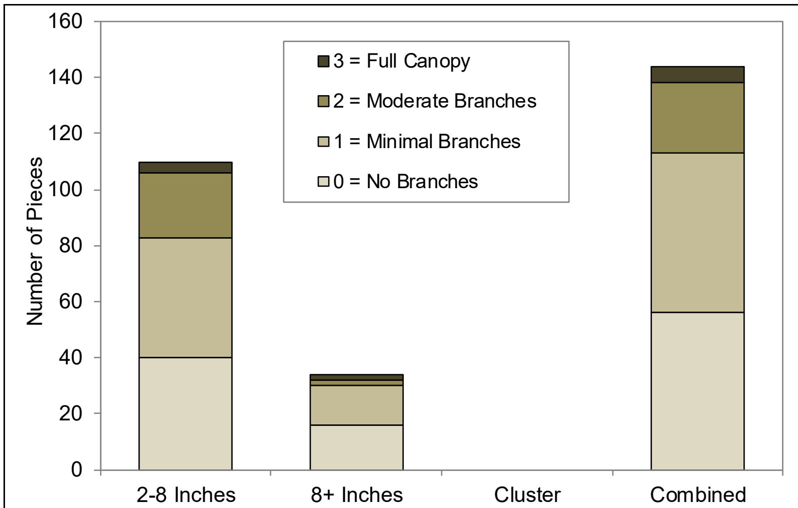


Figure 8.2.3-2. Hiawatha Lake coarse woody habitat survey results. Based upon a late-summer 2015 survey. Locations of Hiawatha Lake coarse woody habitat can be found on Hiawatha Lake – Map 4.

During the coarse woody habitat survey on Hiawatha Lake, a total of 144 pieces were observed along 1.4 miles of shoreline, yielding a coarse woody habitat to shoreline mile ratio of 103:1 (Figure 8.2.3-2). Onterra ecologists have been completing these surveys on Wisconsin's lakes for five years, and Hiawatha Lake has one the highest coarse woody habitat pieces per shoreline recorded on any Onterra project to date. Refraining from removing these woody habitats from the shoreland area will ensure this high-quality habitat remains in these lakes. The locations of these coarse woody habitat pieces are displayed on Hiawatha Lake – Map 4.

8.2.4 Hiawatha Lake Aquatic Vegetation

An Early-Season Aquatic Invasive Species (ESAIS) Survey was conducted by Onterra ecologists on Hiawatha Lake on June 29, 2015. While the intent of this survey is to locate any potential non-native species within the lake, the primary focus is to locate potential occurrences of the non-native curly-leaf pondweed, which should be at or near its peak growth at this time. No curly-leaf pondweed or any non-native aquatic plant species were located in Hiawatha Lake during this survey or any survey completed in 2015.

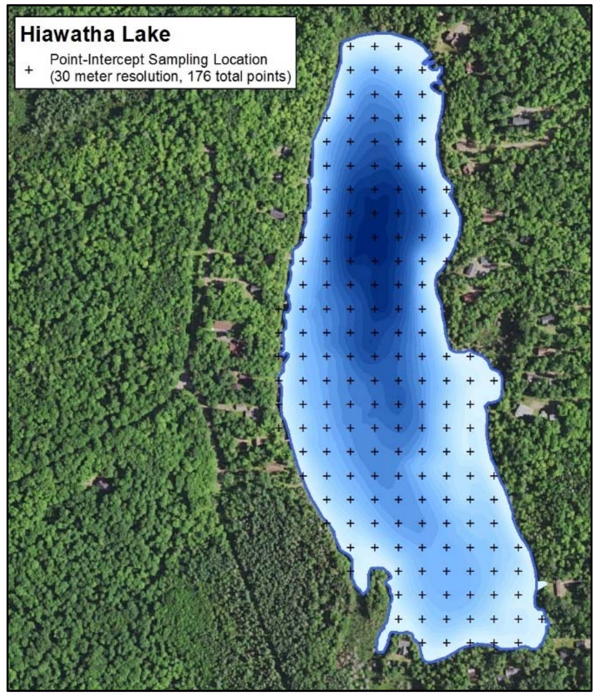


Figure 8.2.4-1. Hiawatha Lake whole-lake point-intercept survey sampling locations.

The whole-lake aquatic plant point-intercept survey and emergent and floating-leaf aquatic plant community mapping survey were conducted on Hiawatha Lake by Onterra ecologists on August 18, 2015 (Figure 8.2.4-1). During these surveys, a total of 26 aquatic plant species were located, all of which are considered to be native species (Table 8.2.4-1). Lakes in Wisconsin vary in their morphometry, water chemistry, and substrate composition, and all of these factors influence aquatic plant community composition. In early August of 2015, Onterra ecologists completed an acoustic survey on Hiawatha Lake (bathymetric results shown in introduction). The sonar-based technology records aquatic plant bio-volume, or the percentage of the water column that is occupied by aquatic plants at a given location. Data pertaining to Hiawatha Lake's substrate composition were also recorded during this survey. The sonar records substrate hardness, ranging from the hardest substrates (i.e. rock and sand) to the more flocculent, softer organic sediments.

Data regarding substrate hardness collected during the 2015 acoustic survey reveals that Hiawatha Lake's average substrate hardness ranges from hard to moderately hard with few areas containing softer, flocculent sediments (Figure 8.2.4-2 and Hiawatha Lake – Map 5). Substrate hardness is highest within the shallowest areas of Hiawatha Lake. From 15 and deeper, substrate hardness remains relatively constant. Figure 8.2.4-3 illustrates the spatial distribution of substrate hardness in Hiawatha Lake. Like terrestrial plants, different aquatic plant species are adapted to grow in certain substrate types; some species are only found growing in soft substrates, others only in sandy areas, and some can be found growing in either. Lakes that have varying substrate types generally support a higher number of plant species because of the different habitat types that are available.

Table 8.2.4-1. Hiawatha Lake 2015 list of aquatic plant species.

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism (C)	2015 (Onterra)
Emergent	*Carex aquatilis*	Long-bracted tussock sedge	7	I
	Carex lasiocarpa	Narrow-leaved woolly sedge	9	I
	Carex utriculata	Common yellow lake sedge	7	I
	Dulichium arundinaceum	Three-way sedge	9	I
	Eleocharis palustris	Creeping spikerush	6	X
	Equisetum fluviatile	Water horsetail	7	X
	Glyceria canadensis	Rattlesnake grass	7	I
	Juncus effusus	Soft rush	4	I
	Schoenoplectus tabernaemontani	Softstem bulrush	4	I
	Scirpus cyperinus	Wool grass	4	I
	Typha spp.	Cattail spp.	1	I
FL/E	*Sparganium emersum*	Short-stemmed bur-reed	8	I
FL	*Nuphar variegata*	Spatterdock	6	X
	Sparganium fluctuans	Floating-leaf bur-reed	10	I
Submergent	*Callitriche palustris*	Common water starwort	8	I
	Chara spp.	Muskgrasses	7	X
	Eriocaulon aquaticum	Pipewort	9	X
	Fontinalis sphagnifolia	Rolled water moss	N/A	X
	Isoetes spp.	Quillwort spp.	8	X
	Najas flexilis	Slender naiad	6	X
	Nitella spp.	Stoneworts	7	X
	Potamogeton berchtoldii	Slender pondweed	7	X
	Potamogeton epihydrus	Ribbon-leaf pondweed	8	X
	Potamogeton gramineus	Variable-leaf pondweed	7	X
	Potamogeton natans	Floating-leaf pondweed	5	I
	Potamogeton spirillus	Spiral-fruited pondweed	8	X

FL/E = Floating Leaf and Emergent; FL = Floating Leaf
X = Located on rake during point-intercept survey; I = Incidental Species

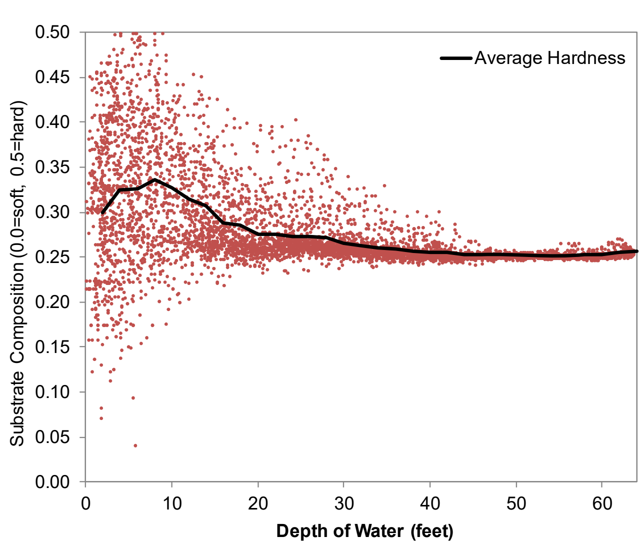


Figure 8.2.4-2. Hiawatha Lake substrate hardness across water depth. Individual data points are displayed in red. Creating using data from August 2015 acoustic survey.

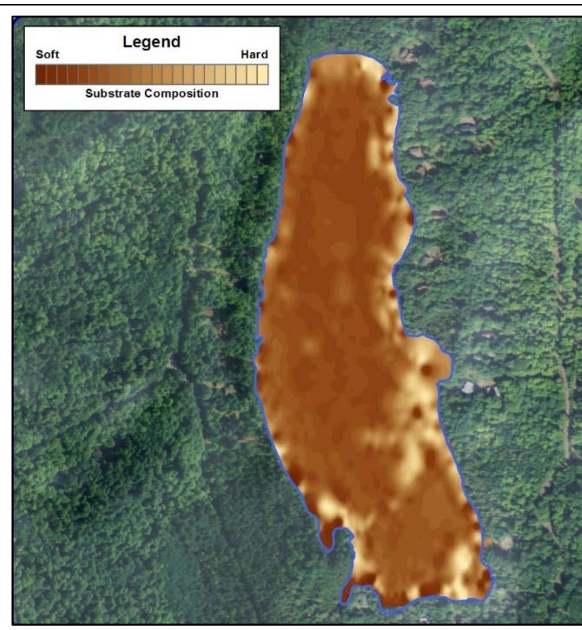


Figure 8.2.4-3. Hiawatha Lake substrate hardness. Created using data from August 2015 acoustic survey.

The acoustic survey also recorded aquatic plant bio-volume throughout the entire lake. As mentioned earlier, aquatic plant bio-volume is the percentage of the water column that is occupied by aquatic plants. The 2015 aquatic plant bio-volume data are displayed in Figure 8.2.4-4 and Hiawatha Lake – Map 6. Areas where aquatic plants occupy most or all of the water column are indicated in red while areas of little to no aquatic plant growth are displayed in blue. These data indicate that Hiawatha Lake is sparsely vegetated. The majority of aquatic plant growth occurs within first 10 feet of water, and the presence of aquatic plants quickly diminished beyond 10 feet. Overall, the 2015 acoustic survey indicates that approximately 4% of Hiawatha Lake contains aquatic vegetation (Figure 8.2.4-4). The remaining area of the lake is too deep to support aquatic plant growth.

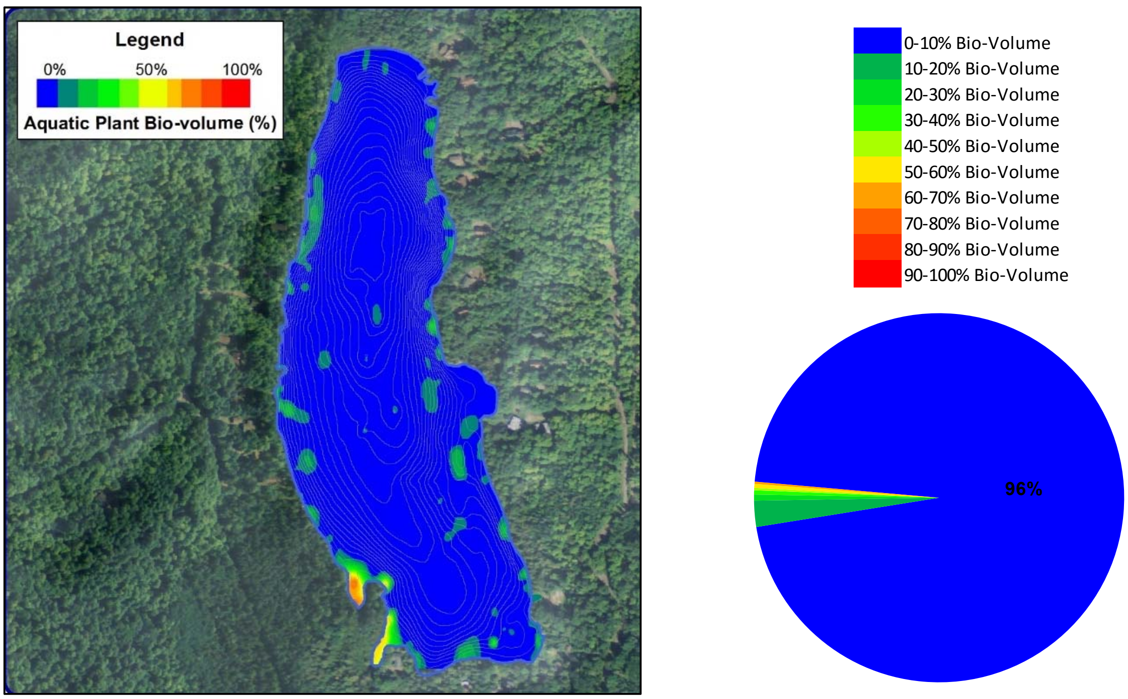


Figure 8.2.4-4. Hiawatha Lake 2015 aquatic plant bio-volume. Created using data from August 2015 acoustic survey data. Contour lines represent three-foot increments.

While the acoustic mapping is an excellent survey for understanding the distribution and levels of aquatic plant growth throughout the lake, this survey does not determine what aquatic plant species are present. Whole-lake point-intercept surveys are used to quantify the abundance of individual species within the lake. During the 2015 aquatic plant point-intercept survey, the maximum depth recorded with aquatic plants was 11 feet. Of the 36 point-intercept sampling locations that fell at or shallower than the maximum depth of plant growth (the littoral zone), approximately 50% contained aquatic vegetation. Aquatic plant rake fullness data collected in 2015 indicates that 39% of the 36 sampling locations contained vegetation with a total rake fullness rating (TRF) of 1, 8% had a TRF rating of 2, and 3% had a TRF rating of 3 (Figure 8.2.4-5).

Of the 26 aquatic plant species located in Hiawatha Lake in 2015, 13 were encountered directly on the rake during the whole-lake point-intercept survey (Figure 8.2.4-6). The remaining 13 plants were located incidentally, meaning they were observed by Onterra ecologists while on the lake but they were not directly sampled on the rake at any of the point-intercept sampling locations. Incidental species typically include emergent and floating-leaf species that are often found growing on the fringes of the lake and submersed species that are relatively rare within the plant community. Of the 13 species directly sampled with the rake during the point-intercept survey, rolled water moss, ribbon-leaf pondweed, slender pondweed, and slender naiad were the four-most frequently encountered aquatic plants, respectively (Figure 8.2.4-6).

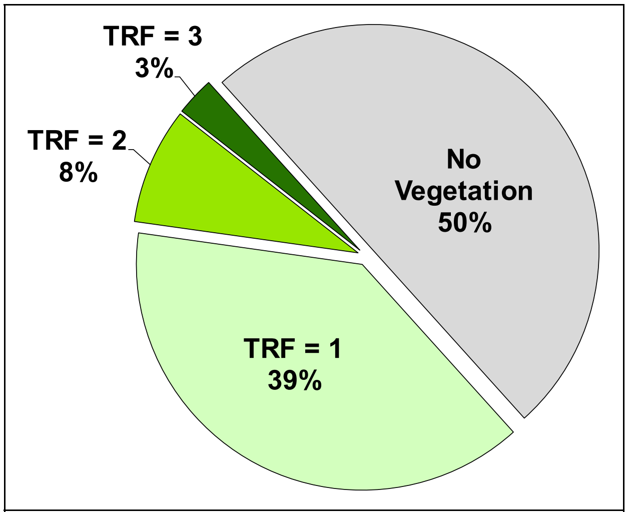


Figure 8.2.4-5. Hiawatha Lake 2015 aquatic vegetation total rake fullness ratings (TRF). Created from data collected during the 2015 whole-lake point-intercept survey (N = 36).

Rolled water moss was the most frequently encountered aquatic plant in Hiawatha Lake in 2015 with a littoral frequency of occurrence of approximately 33% (Figure 8.2-4-6). Like other aquatic bryophytes, rolled water moss is only able to utilize dissolved carbon dioxide for within the water for photosynthesis and is unable to use bicarbonate. Consequently, aquatic mosses tend to dominate in lakes like Hiawatha that have low bicarbonate concentrations and higher concentrations of dissolved carbon dioxide. The plants are also able to tolerate low-light conditions, and rolled water moss was the deepest growing aquatic plant located in Hiawatha Lake in 2015. These plants provide valuable structural habitat to aquatic wildlife.

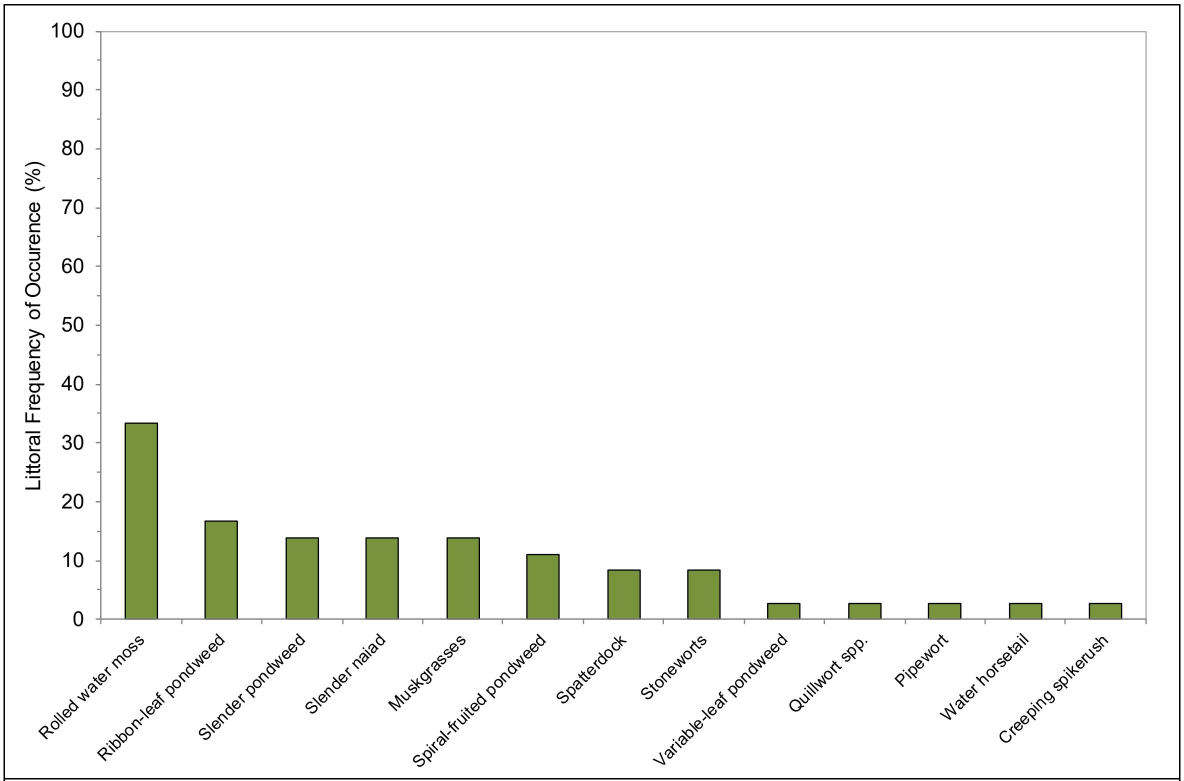


Figure 8.2.4-6. Hiawatha Lake 2015 littoral frequency of occurrence of aquatic plant species. Created using data from 2015 whole-lake point-intercept survey.

Ribbon-leaf pondweed (Photo 8.2.4-1), the second-most frequently encountered aquatic plant in Hiawatha Lake in 2015 with a littoral frequency of occurrence of approximately 17% is another aquatic plant species that is mainly found in lakes with lower alkalinity. This pondweed possesses long, ribbon-like submersed leaves, and as it grows near the surface it produces oval-shaped floating-leaves which aid in keeping the plants flowers above the surface where they can be pollinated. Like other aquatic plants, ribbon-leaf pondweed provides valuable structural habitat and its fruit provide a food source to wildlife.

Photo 8.2.4-1. Ribbon-leaf pondweed (*Potamogeton epihydrus*). The second-most frequently encountered plant in Hiawatha Lake. Photo credit Onterra.

Submersed aquatic plants can be grouped into one of two general categories based upon their morphological growth form and habitat preferences. These two groups include species of the *isoetid* growth form and those of the *elodeid* growth form. Plants of the isoetid growth form are small, slow-growing, inconspicuous submerged plants (Photo 8.2.4-2). These species often have evergreen, succulent-like leaves and are usually found growing in sandy/rocky soils within near-shore areas of a lake (Boston and Adams 1987, Vestergaard and Sand-Jensen 2000).

In contrast, aquatic plant species of the elodeid growth form have leaves on tall, erect stems which grow up into the water column, and are the plants that lake users are likely more familiar with (Photo 8.2.4-2). It is important to note that the definition of these two groups is based solely on morphology and physiology and not on species' relationships. For example, dwarf-water milfoil (*Myriophyllum tenellum*) is classified as an isoetid, while all of the other milfoil species in Wisconsin such as northern water milfoil (*Myriophyllum sibiricum*) are classified as elodeids.

Alkalinity, as it relates to the amount of bicarbonate within the water, is the primary water chemistry factor for determining a lake's aquatic plant community composition in terms of isoetid versus elodeid growth forms (Vestergaard and Sand-Jensen 2000). Most aquatic plant species of the elodeid growth form cannot inhabit lakes with little or no alkalinity because their carbon demand for photosynthesis cannot be met solely from the dissolved carbon dioxide within the water and must be supplemented from dissolved bicarbonate.

On the other hand, aquatic plant species of the isoetid growth form can thrive in lakes with little or no alkalinity because they have the ability to derive carbon dioxide directly from the sediment, and many also have a modified form of photosynthesis to maximize their carbon storage (Madsen et al. 2002). While isoetids are able to grow in lakes with higher alkalinity, their short stature makes them poor competitors for space and light against the taller elodeid species. Thus, isoetids are most prevalent in lakes with little to no alkalinity where they can avoid competition from elodeids. However, in lakes with low to moderate alkalinity, like Hiawatha Lake Lake, the aquatic plant community can be comprised of isoetids growing beneath a scattered canopy of the larger elodeids. Isoetid communities are vulnerable to sedimentation and eutrophication (Smolders et al. 2002), and a number are listed as special concern or threatened in Wisconsin due to their rarity and susceptibility to environmental degradation.

Photo 8.2.4-2. Lake quillwort (*Isoetes lacustris*) of the isoetid growth form (left) and variable pondweed (*Potamogeton gramineus*) and fern pondweed (*P. robbinsii*) of the elodeid growth form (right).

As discussed in the Town-wide section, the calculations used to create the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and do not include incidental species. The native species encountered on the rake during 2015 point-intercept survey and their conservatism values were used to calculate the FQI of Hiawatha Lake's aquatic plant community (equation shown below).

$$FQI = \text{Average Coefficient of Conservatism} * \sqrt{\text{Number of Native Species}}$$

Figure 8.2.4-7 compares the 2015 FQI components of Hiawatha Lake to median values of lakes within the Northern Lakes and Forests (NLF) ecoregion and lakes throughout Wisconsin. Hiawatha Lake's native species richness of 13, or the number of native aquatic plant species directly encountered on the rake, falls below the median values for lakes in the NLF ecoregion and for lakes throughout Wisconsin. This is to be expected given Hiawatha Lake's small littoral area, lower water clarity, and lower alkalinity. Only the aquatic plants that are adapted to the carbon-limited, low-light environment found in Harris Lake are going to be able to persist.

While native species richness is low, Hiawatha Lake's average conservatism is high with a value of 7.2. This value exceeds the median values for lakes in the NLF ecoregion and lakes throughout Wisconsin, and indicates that Hiawatha Lake contains a higher number of aquatic plant species that have a higher sensitivity to environmental degradation and require high-quality environments. Using the native species richness and average conservatism yields and FQI value of 25.8, which falls below the median value for lakes in the NLF ecoregion but within the interquartile range for lakes throughout Wisconsin. While Hiawatha Lake contains a lower number of aquatic plant species, the species that are present are of high-quality and are indicative of a healthy lake environment.

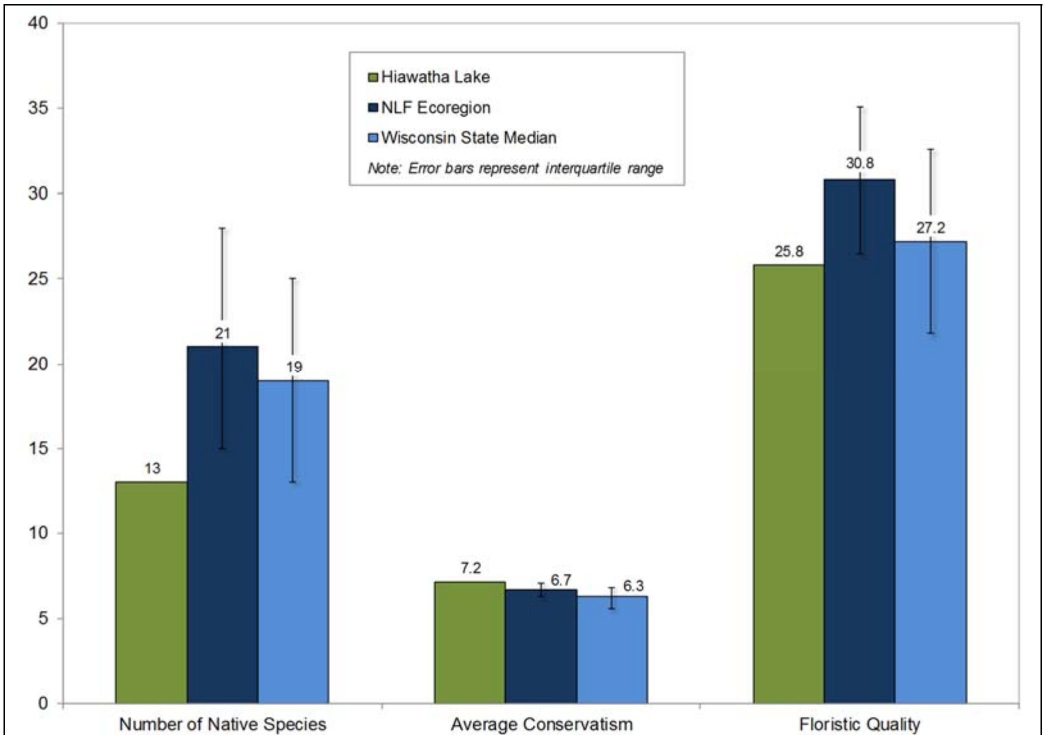


Figure 8.2.4-7. Hiawatha Lake Floristic Quality Assessment. Created using data from Onterra 2015 whole-lake point-intercept surveys. Analysis follows Nichols (1999).

As explained in the Town-wide section, lakes with diverse aquatic plant communities have higher resilience to environmental disturbances and greater resistance to invasion by non-native plants. In addition, a plant community with a mosaic of species with differing morphological attributes provides zooplankton, macroinvertebrates, fish, and other wildlife with diverse structural habitat and various sources of food. Because Hiawatha Lake contains a lower number of native aquatic plant species, one may assume the aquatic plant community also has low species diversity. However, species diversity is also influenced by how evenly the plant species are distributed within the community.

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how Hiawatha Lake's diversity value ranks. Using data collected by Onterra and WDNR Science Services, quartiles were calculated for 212 lakes within the NLF ecoregion (Figure 8.2.4-8). Using the data collected from the 2015 point-intercept survey, Hiawatha Lake's aquatic plant is shown to have moderate species diversity with a Simpson's Diversity Index value of 0.87. This value is comparable to median species diversity for lakes within the NLF ecoregion and slightly higher than median species diversity for lakes throughout Wisconsin. In other words, if two individual aquatic plants were randomly sampled from Hiawatha Lake in 2015, there would be an 87% probability that they would be different species.

One way to visualize Hiawatha Lake's species diversity is to look at the relative occurrence of aquatic plant species. Figure 8.2.4-9 displays the relative frequency of occurrence of aquatic plant species created from the 2015 whole-lake point-intercept survey and illustrates that rolled water moss comprises approximately 25% of the lake's plant community, while the remaining species are relatively evenly distributed. Because rolled water moss accounts for a quarter of Hiawatha's plant community, species diversity is moderate.

Each sampling location may contain numerous plant species, and relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while rolled water moss was found at 33% of the littoral sampling locations in Hiawatha Lake in 2015, its relative frequency of occurrence is 25%. Explained another way, if 100 plants were randomly sampled from Hiawatha Lake in 2015, 25 of would have been rolled water moss.

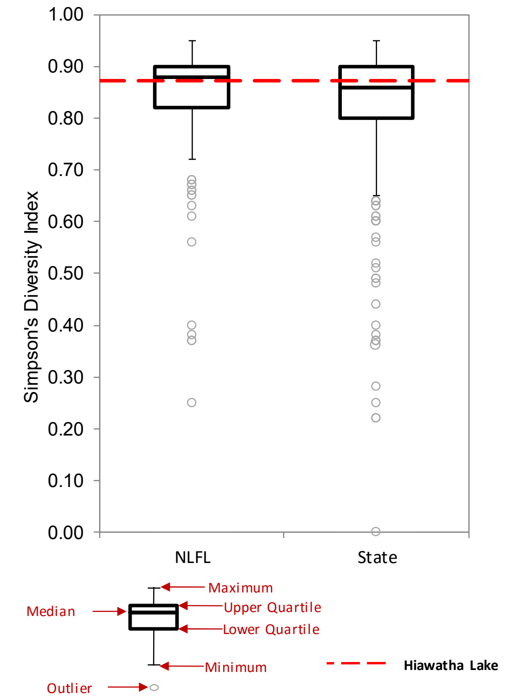


Figure 8.2.4-8. Hiawatha Lake species diversity index. Created using data from Onterra 2015 point-intercept survey.

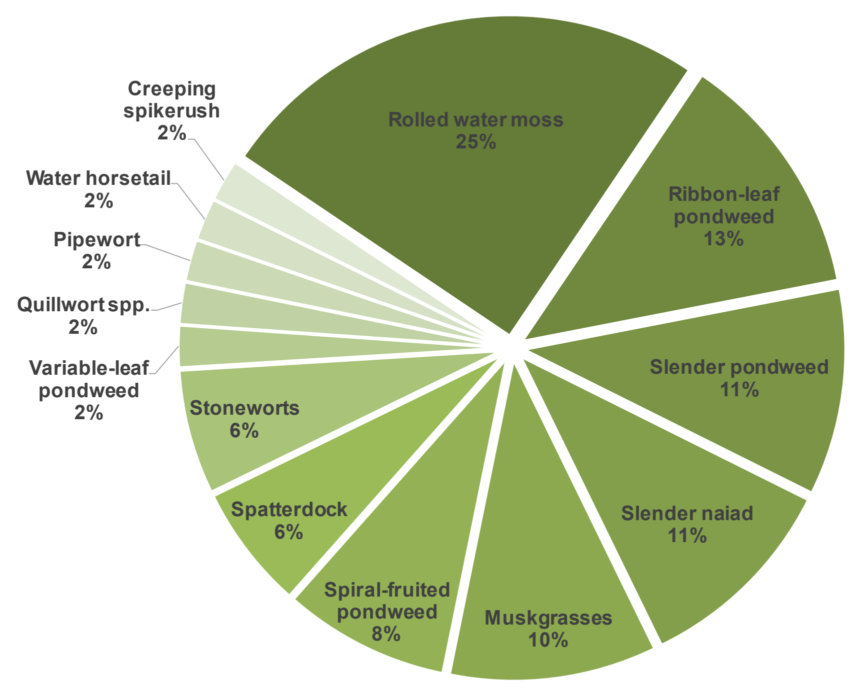


Figure 8.2.4-9. Hiawatha Lake 2015 relative frequency of occurrence of aquatic plant species. Created using data from 2015 point-intercept survey.

In 2015, Onterra ecologists also conducted a survey aimed at mapping emergent and floating-leaf aquatic plant communities in Hiawatha Lake. This survey revealed Hiawatha Lake contains approximately 0.8 acres of these communities comprised of 14 different aquatic plant species (Hiawatha Lake – Map 7 and Table 8.2.4-2). These native emergent and floating-leaf plant communities provide valuable fish and wildlife habitat that is important to the ecosystem of the lake. These areas are particularly important during times of fluctuating water levels, since structural habitat of fallen trees and other forms of course-woody habitat can be quite sparse along the shores of receding water lines.

Table 8.2.4-2. Hiawatha Lake 2015 acres of emergent and floating-leaf aquatic plant communities. Created using data from 2015 aquatic plant community mapping survey.

Hiawatha Lake	
Plant Community	**Acres**
Emergent	0.2
Floating-leaf	0.2
Mixed Emergent & Floating-leaf	0.4
Total	**0.8**

The community map represents a 'snapshot' of the important emergent and floating-leaf plant communities, and a replication of this survey in the future will provide a valuable understanding of the dynamics of these communities within Hiawatha Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development.

8.2.5 Other Aquatic Invasive Species in Hiawatha Lake

As of 2016, no aquatic invasive species have been documented in Hiawatha Lake. As is discussed in previous sections, surveys completed by Onterra ecologists in 2015 did not reveal the presence of any non-native aquatic plants, and plankton tows completed in 2015 were negative for the presence of zebra mussel (*Dreissena polymorpha*) veligers and the spiny waterflea (*Bythrotrephes cederstroemi*). Nearby lakes within the Town of Winchester contain the non-native banded mystery snail (*Viviparus georgianus*), Chinese mystery snail (*Cipanogopaludina chinensis*), freshwater jellyfish (*Craspedacusta sowerbyi*), and the rusty crayfish (*Orconectes rusticus*). It is possible that Hiawatha Lake contains one or more of these non-native invertebrates and that they have just gone unreported.

Rusty crayfish were introduced to Wisconsin from the Ohio River Basin in the 1960's likely via anglers' discarded bait. In addition to displacing native crayfish (*O. virilis* and *O. propinquus*), rusty crayfish also degrade the aquatic habitat by reducing aquatic plant abundance and diversity and have also been shown to consume fish eggs. While there is currently no control method for eradicating rusty crayfish from a waterbody, aggressive trapping and removal has been shown to significantly reduce populations and minimize their ecological impact.

One study conducted in northern Wisconsin lakes found that the Chinese mystery snail did not have strong negative effects on native snail populations (Solomon et al. 2010). However, researchers did detect negative impacts to native snail communities when both Chinese mystery snails and the rusty crayfish were present (Johnson et al. 2009). The ecological impacts from freshwater jellyfish, which are believed to have been introduced from China, are not known. However, it is theorized that these jellyfish may have some impacts to zooplankton communities.

8.2.6 Hiawatha Lake Fisheries Data Integration

Fishery management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a brief summary of available data is included here as reference. The following section is not intended to be a comprehensive plan for the lake's fishery as that is outside of the scope of this project. The goal of this section is to provide an overview of some of the data that exists. Although current fish data were not collected, the following information was compiled based upon data available from the WDNR and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) (WDNR 2016B & GLIFWC 2016A and 2016B).

Hiawatha Lake Fishery

When examining the fishery of a lake, it is important to remember what "drives" that fishery, or what is responsible for determining its mass and composition. The gamefish in Hiawatha Lake are supported by an underlying food chain. At the bottom of this food chain are the elements that fuel algae and plant growth – nutrients such as phosphorus and nitrogen, and sunlight. The next tier in the food chain belongs to zooplankton, which are tiny crustaceans that feed upon algae and plants, and insects. Smaller fish called planktivores feed upon zooplankton and insects, and in turn become food for larger fish species. The species at the top of the food chain are called piscivores, and are the larger gamefish that are often sought after by anglers, such as bass and walleye.

A concept called energy flow describes how the biomass of piscovores is determined within a lake. Because algae and plant matter are generally small in energy content, it takes an incredible amount of this food type to support a sufficient biomass of zooplankton and insects. In turn, it takes a large biomass of zooplankton and insects to support planktivorous fish species. And finally, there must be a large planktivorous fish community to support a modest piscovorous fish community. Studies have shown that in natural ecosystems, it is largely the amount of primary productivity (algae and plant matter) that drives the rest of the producers and consumers in the aquatic food chain. This relationship is illustrated in Figure 8.2.6-1. As discussed in the Water Quality section, Hiawatha Lake is a mesotrophic lake, meaning it has a moderate nutrient content and thus a moderate level of primary productivity. Simply put, this means Hiawatha Lake should be able to support populations of predatory fish (piscivores) because the supporting food chain is relatively robust.

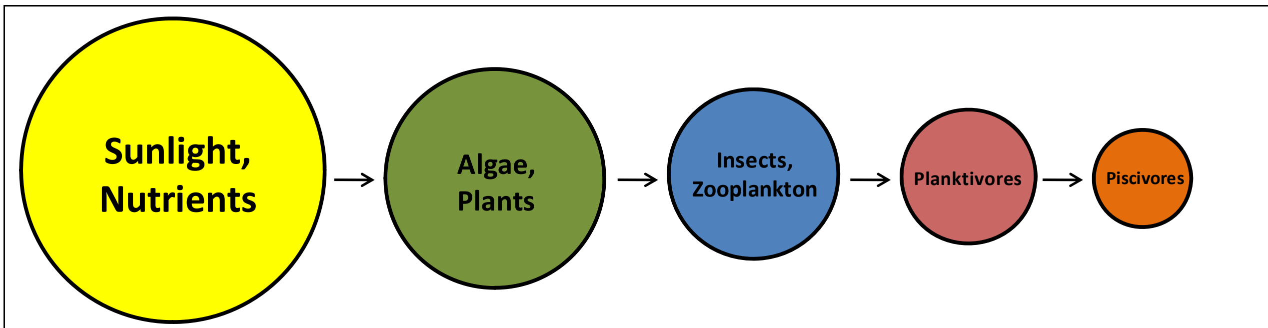


Figure 8.2.6-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

A fish population survey was completed by AquaTech USA in 2011 on Hiawatha Lake, and the species located during this survey as well as species located during previous assessments are found in Table 8.2.6-1. The report indicates that lake property owners have also indicated that muskellunge and lake trout may also be present. They reported walleye are a significant component of the Hiawatha Lake's fishery, and that natural reproduction occurs. Northern pike were the second-most abundant gamefish present, and the presence of tiger musky suggests the presence of muskellunge within the lake as well. The study concluded that additional information would need to be collected to determine if enhancement of the walleye population through stocking would be needed.

Table 8.2-1. Fish species recorded in Hiawatha Lake fisheries assessments.

Scientific Name	Common Name
Ambloplites rupestris	Rock bass
Castostomus commersoni	White sucker
Esox americanus subsp. *vermiculatus*	Grass pickerel
Esox lucius	Northern pike
Esox lucius x *masquinongy*	Tiger musky
Lepomis gibbosus	Pumpkinseed
Lepomis macrochirus	Bluegill
Micropterus salmoides	Largemouth bass
Notropis cornutus	Golden shiner
Perca flavescens	Yellow perch
Pomoxis nigromaculatus	Black crappie
Sander vitreus	Walleye

Hiawatha Lake Tribal Spear Harvest Records

Approximately 22,400 square miles of northern Wisconsin was ceded to the United States by the Lake Superior Chippewa tribes in 1837 and 1842 (Figure 8.2.6-2). The Town of Winchester falls within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on specified systems. Determining how many fish are able to be taken from a lake, either by spear harvest or angler harvest, is a highly regimented and dictated process. This highly structured procedure begins with an annual meeting between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then a "total allowable catch" is established, based upon estimates of a sustainable harvest of the fishing stock (age 3 to age 5 fish). This figure is usually about 35% (walleye) or 27% (muskellunge) of the lake's known or modeled population, but may vary on an individual lake basis due to other circumstances.

In lakes where population estimates are out of date by 3 years, a standard percentage is used. The total allowable catch number may be reduced by a percentage agreed upon by biologists that reflects the confidence they have in their population estimates for the particular lake. This number is called the "safe harvest level". Often, the biologists overseeing a lake cannot make adjustments due to the regimented nature of this process, so the total allowable catch often equals the safe harvest level. The safe harvest is a conservative estimate of the number of fish that can be harvested by a combination of tribal spearing and state-licensed anglers. The safe harvest is then multiplied by the Indian communities claim percent. This result is called the declaration, and represents the maximum number of fish that can be taken by tribal spearers (Spangler, 2009). Daily bag limits for walleye are then reduced for hook-and-line anglers to accommodate the tribal declaration and prevent over-fishing. Bag limits reductions may be increased at the end of May on lakes that are lightly speared. The tribes have historically selected a percentage which allows for a 2-3 daily bag limit for hook-and-line anglers (USDI 2007).

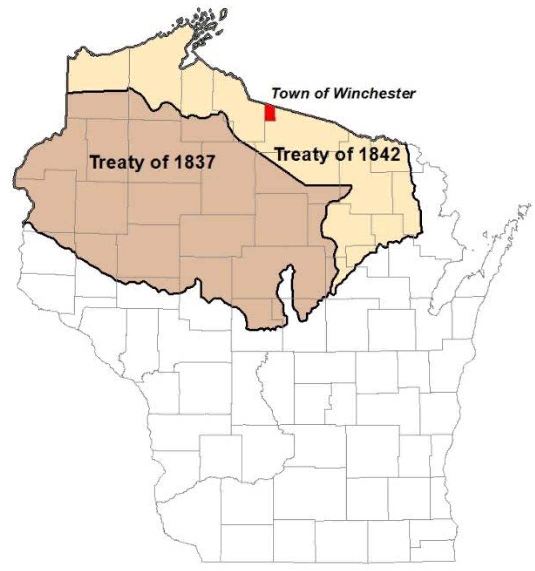


Figure 8.2.6-2. Location of the Town of Winchester within the Native American Ceded Territory (GLIFWC 2016A). This map was digitized by Onterra; therefore it is a representation and not legally binding.

Spear harvesters are able to harvest muskellunge, walleye, northern pike, and bass during the open water season; however, in practice, walleye and muskellunge are the only species harvested in significant numbers, so conservative quotas are set for other species. The spear harvest is monitored through a nightly permit system and a complete monitoring of the harvest (GLIFWC 2016B). Creel clerks and tribal wardens are assigned to each lake at the designated boat landing. A catch report is completed for each boating party upon return to the boat landing. In addition to counting every fish harvested, the first 100 walleye (plus all those in the last boat) are measured and sexed. An updated nightly declaration is determined each morning by 9 a.m. based on the data collected from the successful spear harvesters. Harvest of a particular species ends once the declaration is met or the season ends. In 2011, a new reporting requirement went into effect on lakes with smaller declarations. Starting with the 2011 spear harvest season, on lakes with a harvestable declaration of 75 or fewer fish, reporting of harvests may take place at a location other than the landing of the speared lake.

While within the ceded territory, Hiawatha Lake has not experienced a spearfishing harvest. A small declaration for walleye harvest has been listed for Hiawatha Lake in recent years, however no spearing efforts have been undertaken likely due to the limited population of walleye in the lake and the lake's lack of public access.

Hiawatha Lake Fishing Regulations

The Town of Winchester Lakes are within the northern bass zone in Wisconsin. From May 7 – June 17, smallmouth bass are catch and release only whereas largemouth bass have a daily bag limit of 5 fish and a minimum length of 14 inches. From June 18 to March 5, five largemouth or smallmouth bass in combination may be kept and must be at least 14 inches in length. The Town of Winchester Lakes are in the northern management zone for muskellunge and northern pike. No minimum length limit exists for northern pike and five pike may be kept in a single day. Statewide regulations apply for all other fish species. Wisconsin species regulations are provided in each annual WDNR fishing regulations publication. Anglers should visit the WDNR website (www. http://dnr.wi.gov/topic/fishing/regulations/hookline.html) for specific fishing regulations or visit their local bait and tackle shop to receive a free fishing pamphlet that would contain this information.

Hiawatha Lake Fish Stocking

Stocking of a lake is sometimes done to assist the population of a species due to a lack of natural reproduction in the system, or to otherwise enhance angling opportunities. Fish can be stocked as fry, fingerlings or even as adults. Since Hiawatha Lake does not have public access, the WDNR does not actively stock gamefish in the lake and limited information exists regarding the fishery in Hiawatha Lake. Private stocking has been undertaken historically on the lake and is summarized in table 8.1.5-2. Dating back to 1985, walleye has been periodically stocked in Hiawatha Lake. Limited stocking of rainbow trout (1997) and largemouth bass (1999) have also occurred in the lake.

Table 8.1.5-2. Available Stocking History on Hiawatha Lake.

Hiawatha Lake Fish Stocking Summary			
Year	Species	# Fish Stocked	Avg Fish Length (in)
1985	Walleye	350	6
1997	Walleye	450	6
1997	Rainbow Trout	200	8
1999	Walleye	400	6
1999	Largemouth Bass	200	6
2001	Walleye	550	6
2011	Walleye	257	7-9
2014	Walleye	250	9

Hiawatha Lake Substrate Type

Substrate and habitat are critical to fish species that do not provide parental care to their eggs, in other words, the eggs are left after spawning and not tended to by the parent fish. Walleye is a species that does not provide parental care to its eggs. Walleye preferentially spawn in areas with gravel or rock in places with moving water or wave action, which oxygenates the eggs and prevents them from getting buried in sediment. Fish that provide parental care are less selective of spawning substrates. Species such as bluegill tend to prefer a harder substrate such as rock, gravel or sandy areas if available, but have been found to spawn in muck as well. According to the point-intercept survey conducted by Onterra, the majority (61%) of the substrate in Hiawatha Lake is composed of either sand or gravel/rock, whereas 39% is composed of a soft, mucky or organic substrate.

8.2.7 Hiawatha Lake Implementation Plan

The Implementation Plan presented below was created through the collaborative efforts of the Hiawatha Lake Association (HLA) Planning Committee, Onterra ecologists, and North Lakeland Discovery Center (NLDC) and WDNR staff. It represents the path the HLA will follow in order to meet their lake management goals. The goals detailed within the plan are realistic and based upon the findings of the studies completed in conjunction with this planning project and the needs of the Hiawatha Lake stakeholders as portrayed by the members of the Planning Committee and the numerous communications between Planning Committee members and the lake stakeholders. The Implementation Plan is a living document in that it will be under constant review and adjustment depending on the condition of the lake, the availability of funds, level of volunteer involvement, and the needs of the stakeholders.

Management Goal 1: Maintain current water quality conditions

Management Action: Continue monitoring of Hiawatha Lake's water quality through the WDNR Citizens Lake Monitoring Network (CLMN).

Timeframe: Continuation of current effort

Facilitator: Rolf Ethun (current CLMN volunteer)

Description: Monitoring water quality is an import aspect of every lake management planning activity. Collection of water quality data at regular intervals aids in the management of the lake by building a database that can be used for long-term trend analysis. As discussed in the Water Quality Section, Hiawatha Lake's water quality is excellent, and early detection of potential negative trends may lead to the reason as of why the trend is developing.

The Citizen Lake Monitoring Network (CLMN) is a WDNR program in which volunteers are trained to collect water quality information on their lake. Volunteers from the HLA have been collecting water quality data from Hiawatha Lake annually since 2000. The HLA realizes the importance of continuing this effort, which will supply them with valuable data about their lake. Moving forward, it is the responsibility of Rolf Ethun, current CLMN volunteer, to coordinate new volunteers as needed. When a change in the collection volunteer occurs, Sandy Wickman (715.365.8951) or the appropriate WDNR/UW-Extension staff will need to be contacted to ensure the proper training occurs and the necessary sampling materials are received by the new volunteer. It is also important to note that as a part of this program, the data collected are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS) by the volunteer.

Action Steps:

1. Rolf Ethun, current CLMN volunteer, recruits new volunteer(s) as needed.
2. Volunteer contacts Sandy Wickman (715.365.8951) as needed.

3. Coordinator reports results to WDNR and to HLA members during annual meeting.

Management Action: Preserve natural and restore highly developed shoreland areas on Hiawatha Lake.

Timeframe: Initiate 2017

Facilitator: HLA Board of Directors (suggested)

Description: The 2015 Shoreland Condition Assessment found that approximately 72% (1.0 miles) of Hiawatha Lake's immediate shoreland zone contains little to no development, delineated as either *natural/undeveloped* or *developed-natural*, while approximately 3% (0.04 miles) contains a higher degree of development categorized as *developed-unnatural*. It is important that the owners of properties with little development become educated on the benefits their shoreland is providing to Hiawatha Lake in terms of maintaining the lake's water quality and habitat, and that these shorelands remain in a natural or semi-natural state. It is equally important that the owners of properties with developed shorelands become educated on the lack of benefits and possible harm their shoreland has to Hiawatha Lake's water quality and contribution to habitat loss.

The HLA board of directors will work with appropriate entities such as the NLDC to research grant programs and other pertinent information that will aid the HLA in preserving and restoring Hiawatha Lake's shoreland. This would be accomplished through education of property owners, or direct preservation of land through implementation of conservation easements or land trusts that the property owner would approve of.

Action Steps:

1. HLA Board of Directors gathers appropriate information from entities listed above.
2. The HLA provides Hiawatha Lake property owners with the necessary informational resources to protect or restore their shoreland should they be interested. Interested property owners may contact the NLDC and Vilas County Land and Conservation office for more information on shoreland restoration plans, financial assistance, and benefits of implementation.

Management Action: Preserve natural land cover within Hiawatha Lake's watershed beyond the immediate shoreland zone.

Timeframe: Initiate in 2017

Facilitator: HLA Board of Directors (suggested)

Description: As discussed within the Watershed Section, Hiawatha Lake's watershed or drainage basin is comprised primarily of natural land cover types, forests and wetlands. These natural land cover types export minimal amounts of phosphorus, retain soil, and maintain Hiawatha Lake's excellent water quality. The HLA recognizes the importance of maintaining natural land cover within Hiawatha Lake's watershed to maintain the lake's water quality for future generations.

As discussed in the previous management action, one way the HLA can preserve land within Hiawatha Lake's watershed is through the purchase of land and placement within a land trust. The HLA can also reach out to land owners of property within the lake's watershed and provide them with information on the HLA's mission and why preserving their land in a more natural state is beneficial for water quality. As of 2016, approximately 69% of the land within Hiawatha Lake's watershed is owned by The Forestland Group's Heartwood Forestland Partnership (Figure 8.2.7-1). This land is managed for sustainable logging and is overseen by regional trams working with local forestry consulting firms. The land within Hiawatha Lake's watershed is part of the Great Lakes Region Chippewa East Property. Shawn Hagan is the Senior Director for Forestland Operations (906.487.7491) of the Great Lakes Region for The Forestland Group, and the HLA can contact Shawn for more information on how this property within Hiawatha Lake's watershed is managed.

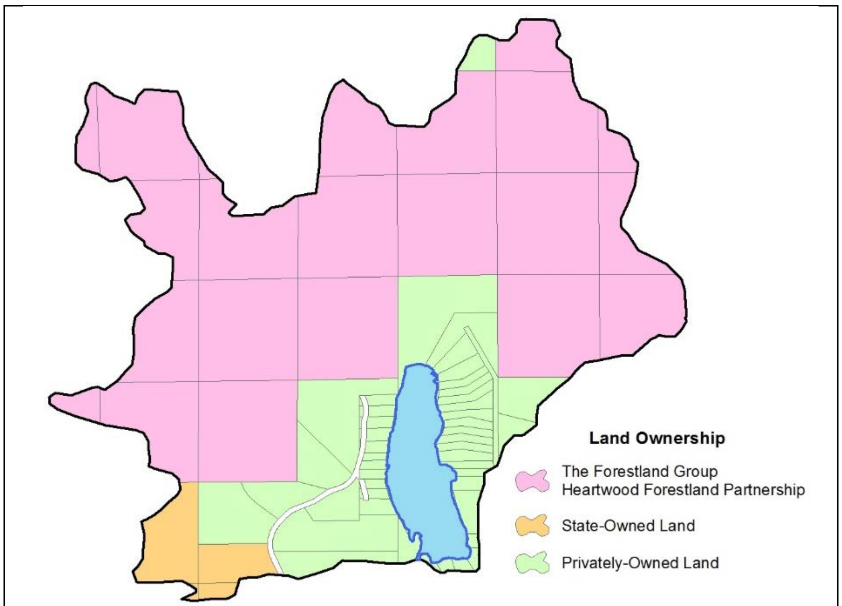


Figure 8.2.7-1. Land ownership within Hiawatha Lake's watershed.

Approximately 4% of the land within Hiawatha Lake's watershed is owned by the Wisconsin Department of Natural Resources, while the remaining 27% is comprised of 45 privately-owned parcels. Of these 45 parcels, 39 border Hiawatha Lake and seven are currently privately-owned trusts. In an effort to preserve natural land cover on these properties, the HLA can include information on the benefits of maintaining these properties in a natural state along with information on the benefits of maintaining a natural shoreline as discussed in the previous management action.

Action Steps:

1. See description above.

Management Goal 2: Assure and Enhance the Communication and Outreach of the Hiawatha Lake Association with Hiawatha Lake Stakeholders

Management Action: Promote stakeholder involvement, inform stakeholders on various lake issues, as well as the quality of life on Hiawatha Lake.

Timeframe: Continuation of current effort

Facilitator: HLA Board of Directors (suggested)

Description: Education represents an effective tool to address lake issues like shoreline development, invasive species, water quality, lawn fertilizers, as well as other concerns such as community involvement and boating safety. The HLA will continue its effort to promote lake preservation and enhancement through a variety of educational efforts.

Currently, the HLA regularly publishes and distributes an electronic newsletter three to four times per year that provides association-related information including current association projects and updates, meeting times, and educational topics. This is an excellent source for communication to association members. In addition, the HLA reaches out to new property owners to inform them about the benefits of becoming an association member.

The majority of Hiawatha Lake stakeholder survey respondents indicated that the HLA keeps them highly informed regarding issues with the lake and its management. The HLA would like to maintain its capacity to reach out to and educate association and non-association members regarding Hiawatha Lake and its preservation. Education of lake stakeholders on all matters is important, and a list of educational topics that were discussed during the planning meetings can be found below. These topics can be included within the association's newsletter or distributed as separate educational materials. In addition, the HLA can invite professionals who work within these topics to come and speak at the association's annual meeting or hold workshops if available.

Example Educational Topics

- Shoreline restoration and protection
- Effect lawn fertilizers/herbicides have on the lake

- Importance of maintaining course woody habitat
- Fishing rules and regulations
- Catch-and-release fishing
- Boating regulations and safety
- Pier regulations and responsible placement to minimize habitat disturbance
- Importance of maintaining a healthy native aquatic plant community
- Respect to and maintaining a safe distance from wildlife (e.g. loons) within the lake
- Aquatic invasive species (AIS) prevention
- Water quality monitoring updates from Hiawatha Lake
- Septic system maintenance
- Littering on the ice and year-round

Action Steps:

1. See description above.

Management Goal 3: Prevent Aquatic Invasive Species Introductions to Hiawatha Lake

Management Action: Continue HLA volunteer aquatic invasive species monitoring using the shoreline monitors.

Timeframe: Continuation of current effort.

Facilitator: HLA Board of Directors (suggested)

Description: To date, no aquatic invasive species have been documented in Hiawatha Lake. However, nearby lakes such as Big Lake and the Manitowish Chain of Lakes harbor populations of curly-leaf pondweed, while nearby Presque Isle Lake contains a population of Eurasian water milfoil. While Hiawatha Lake does not contain public access, lake property owners need to be vigilant that they are not introducing aquatic invasive species to Hiawatha Lake when launching their watercraft.

In lakes without Eurasian water milfoil and curly-leaf pondweed, early detection of these can often lead to successful control, and in instances with small infestations, possible even eradication. Currently, HLA volunteers have received aquatic invasive species identification and monitoring training and perform shoreline surveys in which volunteers are responsible for periodically monitoring specific areas of the lake. This methodology allows the entire lake to be monitored for the presence of non-native species.

Action Steps:

1. HLA volunteers updated their identification and monitoring skills by attending training sessions provided by the NLDC (877.543.2085).
2. Trained volunteers recruit and train additional association members.

3. Complete monitoring surveys following protocols.

Management Action: Initiate aquatic invasive species rapid response plan upon discovery of new infestation.

Timeframe: Initiate upon invasive species discovery.

Facilitator: HLA Board of Directors (suggested)

Description: In the event that an aquatic invasive species such as Eurasian water milfoil is located by the trained volunteers, the areas would be marked using GPS and the HLA should contact resource managers immediately. The areas marked by volunteers would serve as focus areas for professional ecologists, and these areas would be surveyed by professionals during the plant's peak growth phase and the results would be used to develop potential control strategies.

Action Steps:

1. See description above.

Management Goal 4: Enhance the fishery of Hiawatha Lake

Management Action: Continue work with WDNR fisheries managers to enhance the fishery of Hiawatha Lake.

Timeframe: Continuation of current effort

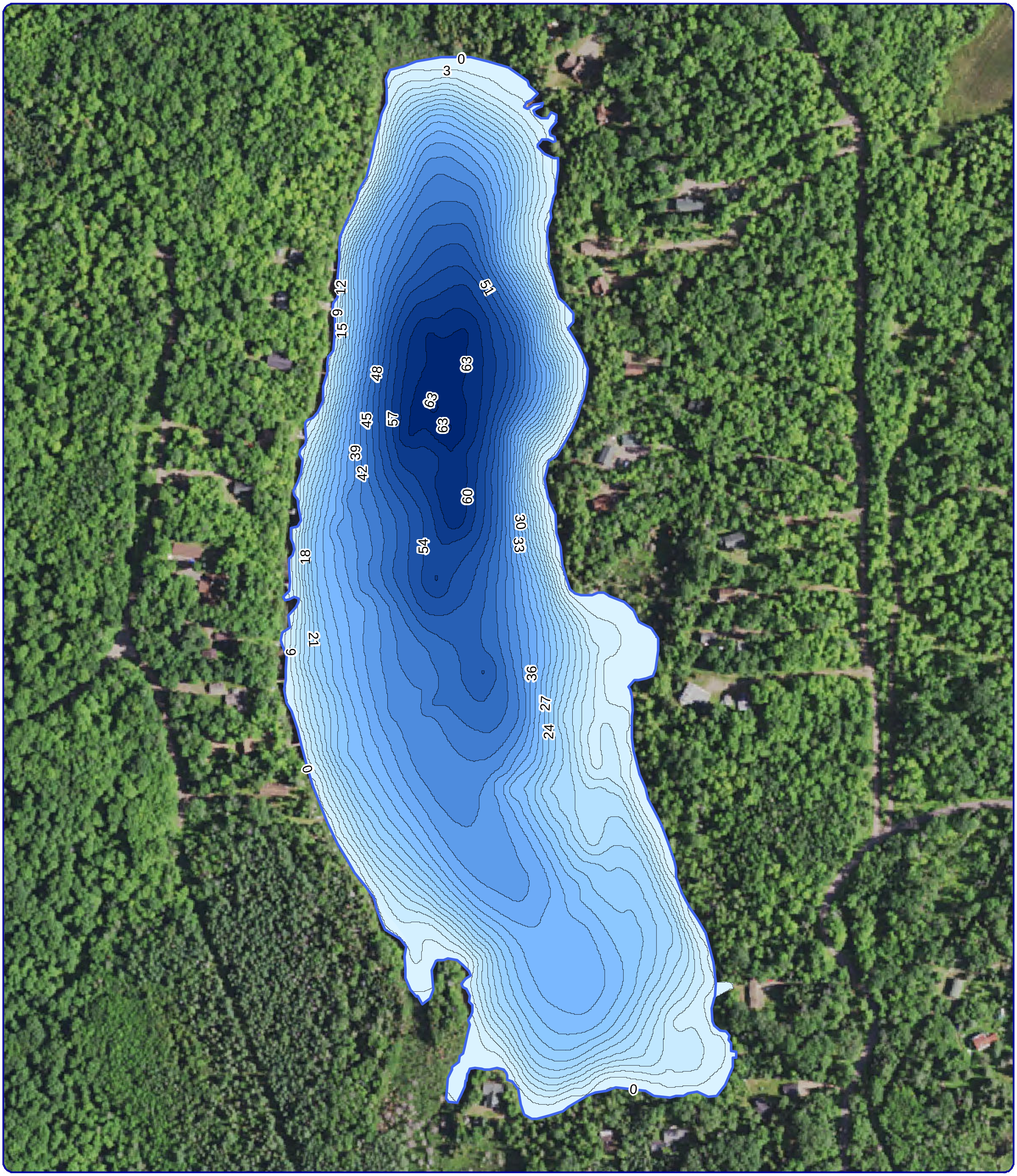
Facilitator: HLA Fisheries Committee (suggested)

Description: The Hiawatha Lake stakeholder survey indicated that walleye are the most sought after gamefish for Hiawatha Lake stakeholders. As is discussed in the Hiawatha Lake Fisheries Data Integration Section, a population survey in 2011 found that walleye were the most abundance gamefish present in Hiawatha Lake. The report indicated that natural reproduction of walleye is occurring, but additional surveys would be needed to determine if stocking would be needed to enhance the population.

While the majority of survey respondents indicated that current quality of fishing on Hiawatha Lake is *fair* or *good*, the planning committee indicated that the HLA would like to work to enhance the lake's fishery, specifically the lake's walleye population. Hiawatha Lake is currently overseen by WDNR fisheries biologist Steve Gilbert. The HLA Fisheries Committee should contact Mr. Gilbert regarding enhancement of the lake's walleye population, which has included stocking in the past. In addition, the committee should contact Mr. Gilbert on an annual basis (perhaps during the winter months when field work is not occurring) for a brief summary of any activities that took place or are planned for Hiawatha Lake. Additionally, the HLA Fisheries Committee may discuss options for improving the fishery in Hiawatha Lake, which may include changes in angling regulations and habitat enhancements.

Action Steps:

1. See description above.



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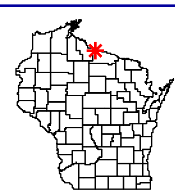
Sources:
Orthophotography: NAIP 2013
Bathymetric Survey: Onterra 2015
Map Date: May 25, 2016
Filename: Map1_Hiawatha_Location.mxd



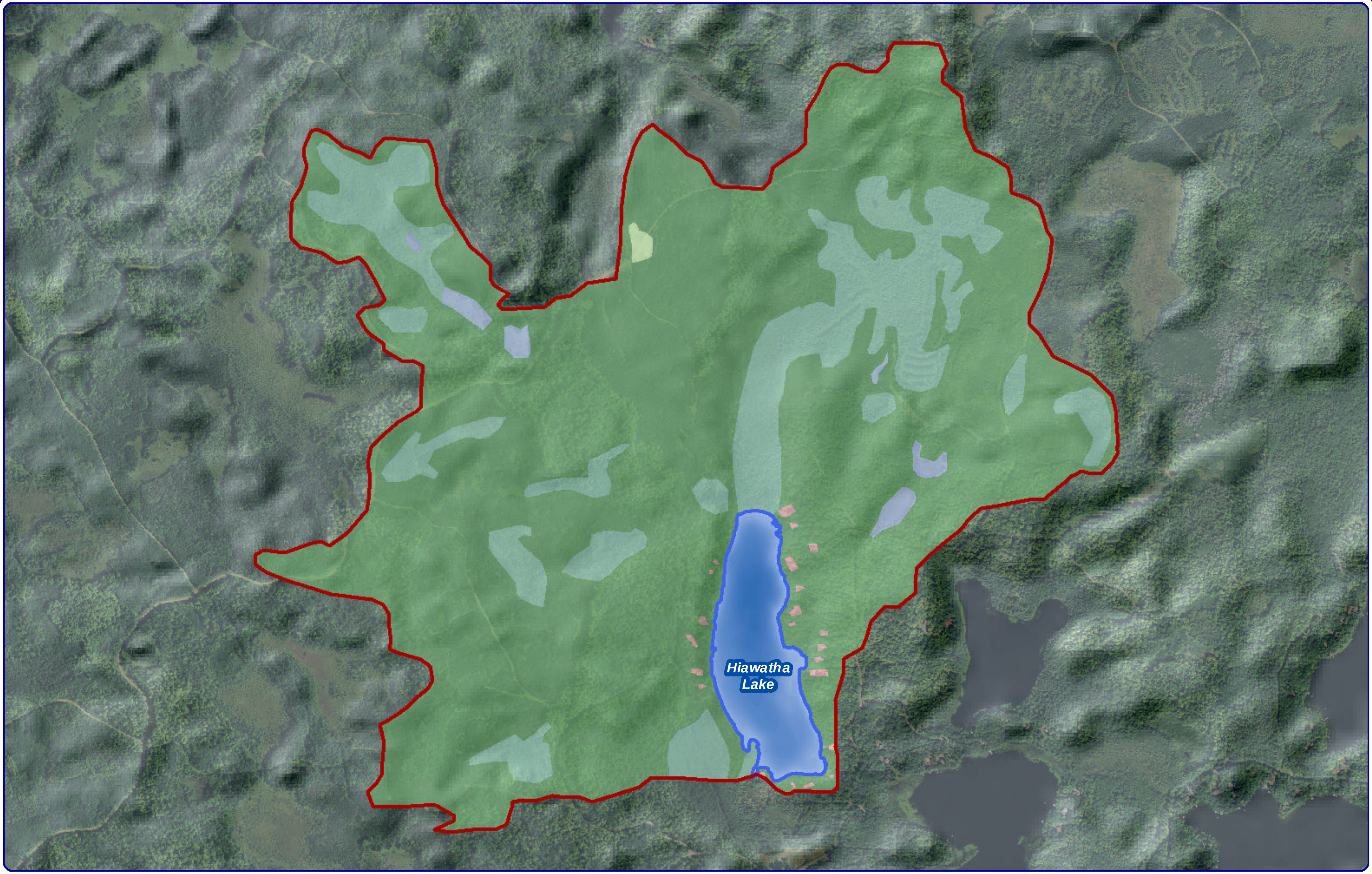
Project Location in Wisconsin

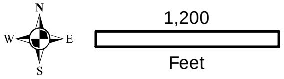
Legend

Hiawatha Lake ~36 acres
WDNR Definition

Hiawatha Lake - Map 1
Town of Winchester
Vilas County, Wisconsin

Project Location & Lake Boundaries





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Sources:
Hydro: WDNR
Bathymetry: Onterra 2015
Orthophotography: NAIP 2013
Land Cover: NLCD 2011
Watershed Boundaries: Onterra 2016
Map Date: May 25, 2016
Filename: Map2_Hiawatha_WS.mxd

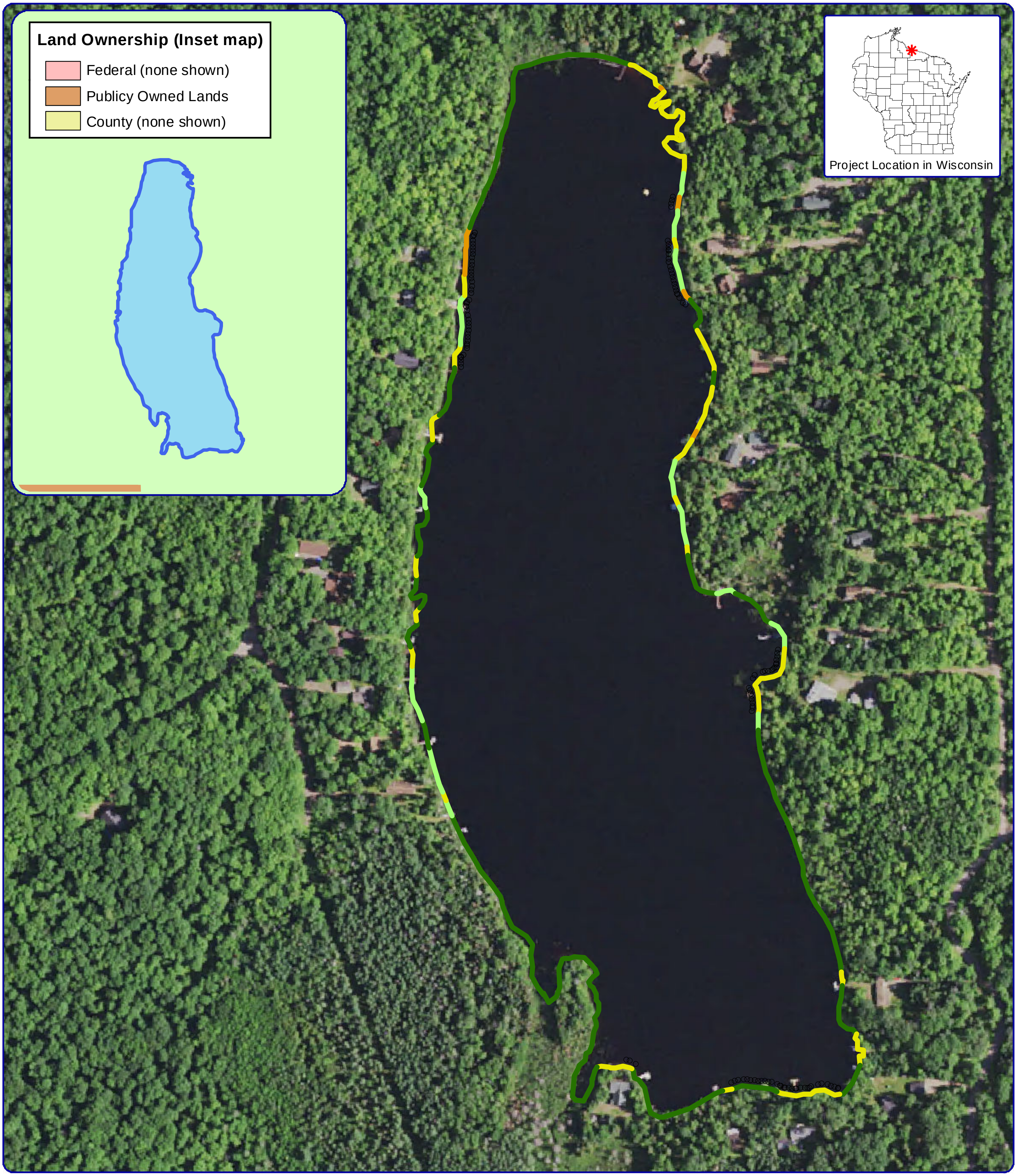
Project Location in Wisconsin

Legend

- Hiawatha Lake Watershed
- Hiawatha Lake
- Forest
- Forested Wetlands
- Pasture/Grass
- Rural Residential
- Non-Forested Wetlands
- Open Water
- River/Stream

Hiawatha Lake - Map 2
Town of Winchester
Vilas County, Wisconsin

Watershed Boundaries & Land Cover Types



N
W E
S
300
Feet

Legend

- Natural/Undeveloped
- Developed-Natural
- Developed-Semi-Natural
- Developed-Unnatural
- Urbanized

Seawall

- Masonry/Wood/Metal
- Rip-Rap

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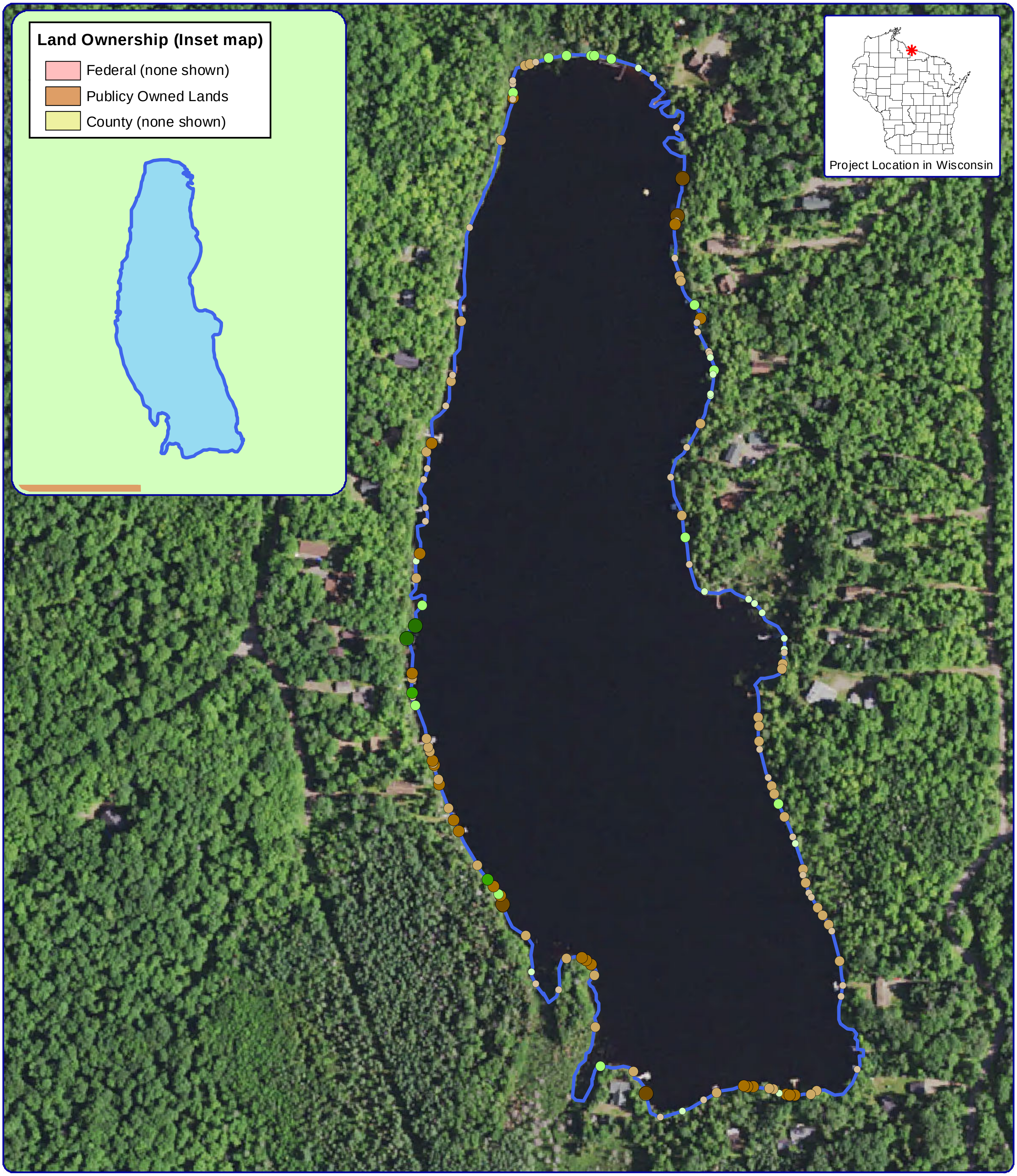
Sources:
Orthophotography: NAIP 2015
Shoreland Condition: Onterra 2015
Map Date: May 25, 2016
Filename: Map3_Hiawatha_SA_2015.mxd

Hiawatha Lake - Map 3

Town of Winchester

Vilas County, Wisconsin

2015 Shoreline Condition



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W E
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300
Feet

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Sources:
Orthophotography: NAIP 2015
Shoreland Condition: Onterra 2015
Map Date: May 25, 2016
Filename: Map4_Hiawatha_CWH_2015.mxd

Legend

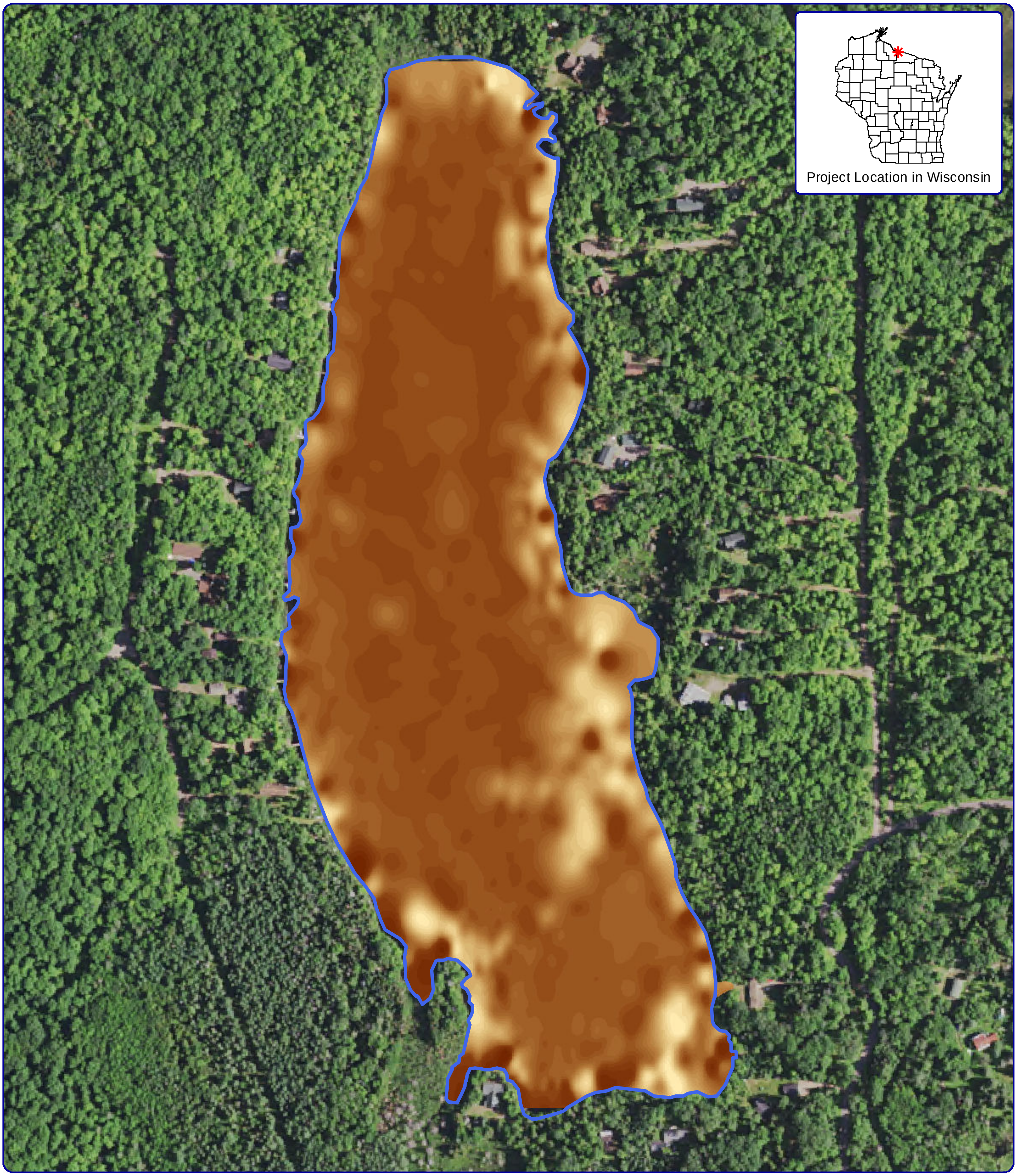
2-8 Inch Pieces	8+ Inch Pieces	Cluster of Pieces
No Branches	No Branches	No Branches (none)
Minimal Branches	Minimal Branches	Minimal Branches (none)
Moderate Branches	Moderate Branches	Moderate Branches (none)
Full Canopy	Full Canopy	Full Canopy (none)

Hiawatha Lake - Map 4

Town of Winchester

Vilas County, Wisconsin

2015 Coarse Woody Habitat



N
W E
S

300
Feet

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Sources:
Orthophotography: NAIP 2013
Acoustic Survey: Onterra 2015
Map Date: May 25, 2016
Filename: Map5_Hiawatha_SubHard_2015.mxd

Legend

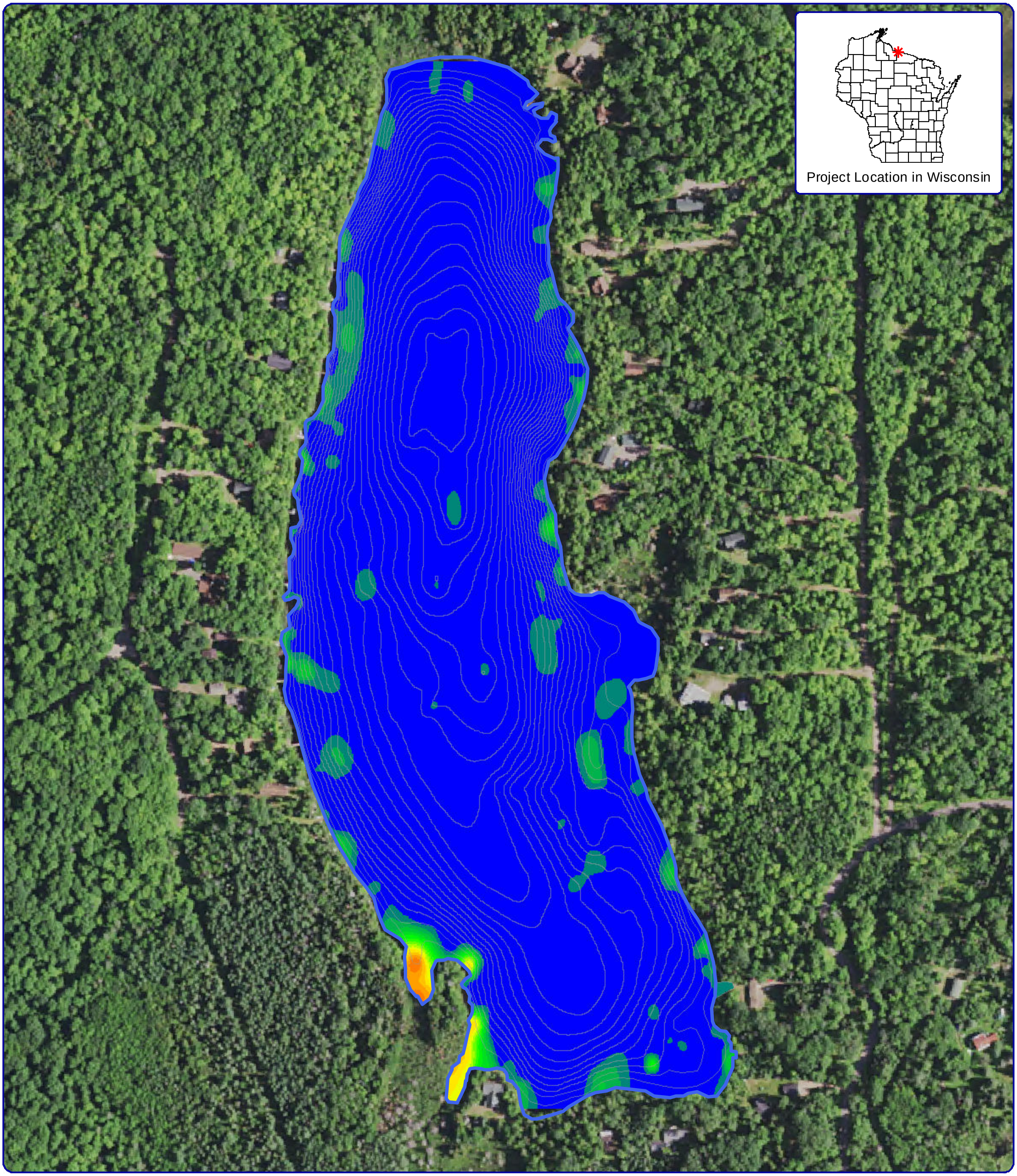
Soft **Hard**

Substrate Composition

Hiawatha Lake - Map 5

Town of Winchester
Vilas County, Wisconsin

2015 Acoustic Survey:
Substrate Hardness



N
W E
S

300
Feet

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Sources:
Orthophotography: NAIP 2013
Acoustic Survey: Onterra 2015
Map Date: May 25, 2016
Filename: Map6_Hiawatha_BioVol_2015.mxd

Legend

0% 50% 100%

Aquatic Plant Bio-volume (%)

Hiawatha Lake - Map 6

Town of Winchester

Vilas County, Wisconsin

2015 Acoustic Survey:
Aquatic Plant Bio-Volume

N
W E
S

320

Feet

Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

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920.338.8860
www.onterra-eco.com

Sources:
Orthophotography: NAIP 2013
Aquatic Plants: Onterra, 2015
Map Date: May 25, 2016
Filename: Map7_Hiawatha_Comm_2015.mxd

Hiawatha Lake - Map 7

Town of Winchester
Vilas County, Wisconsin

2015 Emergent & Floating-leaf Plant Communities